EVALUATION OF FETAL KIDNEY LENGTH MEASUREMENT IN ESTIMATION OF GESTATIONAL AGE IN LATE TRIMESTER

Dissertation Submitted to
THE TAMILNADU DR. M.G.R. MEDICAL UNIVERSITY

In partial fulfillment of the regulations for the award of the degree of

M.S (BRANCH-II)

OBSTETRICS & GYNAECOLOGY

CHENGALPATTU MEDICAL COLLEGE
THE TAMILNADU DR.M.G.R. MEDICAL UNIVERSITY
CHENNAI, INDIA.

APRIL 2014

BONAFIDE CERTIFICATE

This is to certify that the dissertation titled **"EVALUATION OF FETAL KIDNEY LENGTH MEASUREMENT IN ESTIMATION OF GESTATIONAL AGE IN LATE TRIMESTER"** is the original work done by **Dr.C.M.SHANMUGHAVADIVU,** postgraduate in the Department of Obstetrics and Gynaecology, Chengalpattu Medical College, Chengalpattu, to be submitted to The Tamilnadu Dr. M.G.R. Medical University, Chennai – 600 032, towards the partial fulfillment of the requirement for the award of M.S. Degree in Obstetrics and Gynaecology, April 2014.

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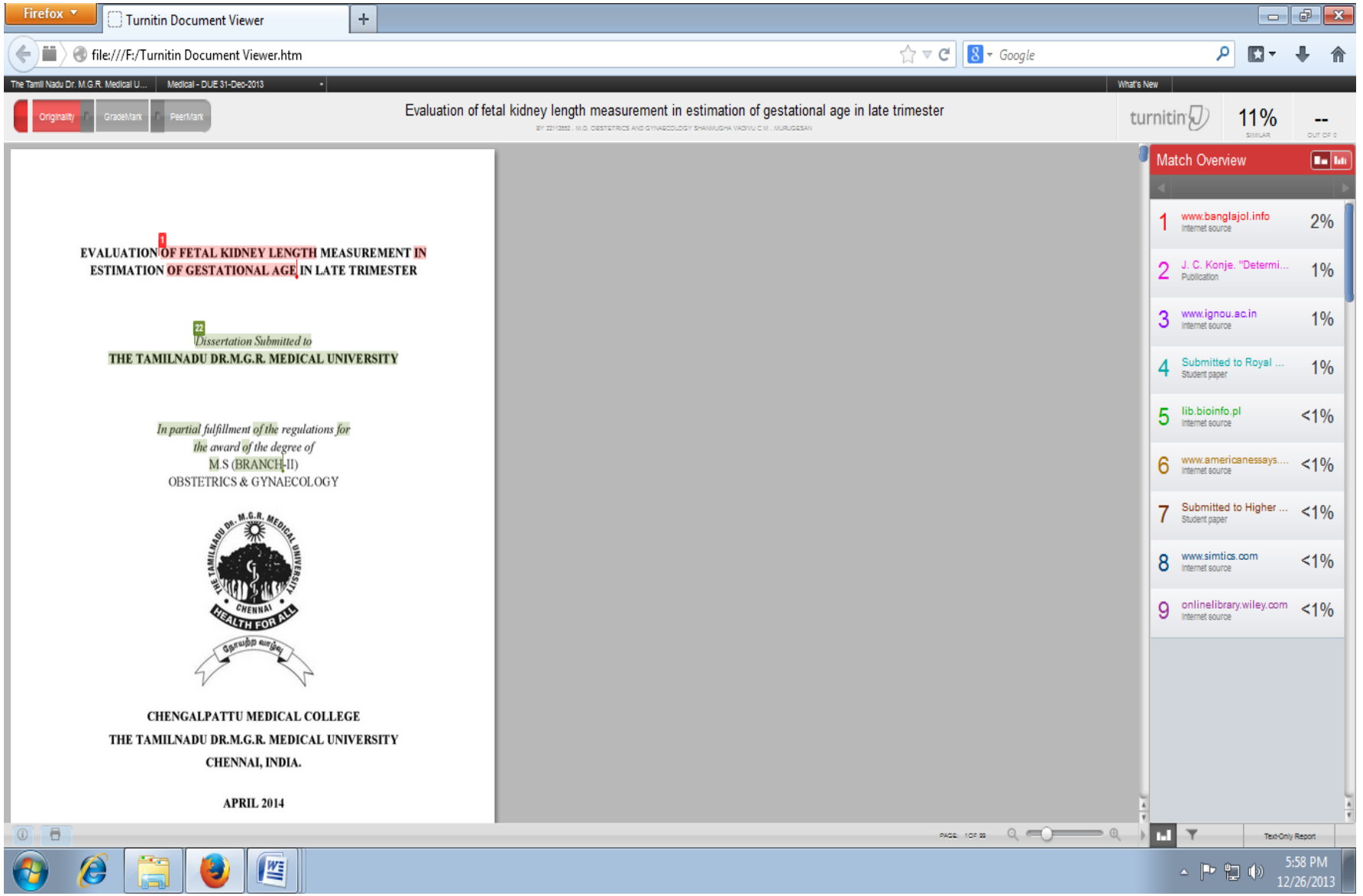
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CHENGELPETTU MEDICAL COLLEGE&HOSPITAL, CHENGELPETTU

APPROVAL OF ETHICAL COMMITTEE

TO

Dr. C. M. Shanmugavadivu

Dear Dr.

The Institutional Ethical committee of Chengalpattu Medical College & Hospital reviewed and discussed your application to conduct the clinical trial /dissertation work entitled

Evaluation of fetal kidney length measurement in estimation of Gestational age in last trimester

On 14/2/13

The following documents reviewed

a. Trial protocol, dated----------version no
b. Patient information sheet and informed consent form in English and/or vernacular language.
c. Investigators Brochure ,dated----------version
d. Principal investigators current
e. Investigators undertaking

The following members of the Ethics committee were present at the meeting held on

Date 14.2.13 time 12.50 pm place Chengalpattu Medical College.

---------- 14.2.13. ----------Chairman Ethics committee

---------- 14/2/13 ----------member secretary of Ethics committee

Name of each member with designation

Biological scientist

Clinical member

1

2.

Nonclinical member

Lawyer

Member from nongovernment voluntary

Organisation

Philosopher

Lay person

We approve the clinical trial to be conducted in its presented form

The Institutional Ethics committee expects to be informed about the progress of the study, and any SAE occurring in the course of the study, any changes in protocol and patient information/informed consent and asks to provide copy of final report.

Yours sincerely

14/2/13

Member secretory, Ethics committee

ACKNOWLEDGEMENT

I am extremely thankful to **THE DEAN**, **DR.THENMOZHI VALLI M.D.,** Chengalpattu Medical College, Chengalpattu for granting me permission to undertake this study.

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I thank my family and friends for their inspiration and support given to me.

Evaluation Of Fetal Kidney Length Measurement In Estimation Of Gestational Age In Late Trimester.

ABSTRACT :

OBJECTIVE:

To evaluate the accuracy of fetal kidney length measurement in estimating gestational age. To compare its efficacy in estimating gestational age with other routinely used biometric indices and to find out the most accurate parameter in estimating gestational age.

STUDY DESIGN :

Two hundred pregnant women with singleton uncomplicated pregnancies with the gestational age between 24 to 40 weeks of gestation were selected for the study. They underwent ultrasound fetal biometry and fetal kidney length measurement. These measurements were used to date the pregnancies and compared with clinical gestational age derived from last menstrual period and dating scan. Linear regression analysis was done to find out the best parameter for estimating gestational age. Pearson correlation was done to determine the accuracy of these parameters in the dermination of gestational age.

RESULTS:

The mean fetal kidney length showed a linear correlation with gestational age. Fetal kidney length determines gestational age with the accuracy of $\pm$ 9.8 days. BPD dates pregnancy with the accuracy of $\pm$ 11.5 days, Head circumference by $\pm$ 12.4 days, Femur length by $\pm$ 11.3 days, Abdominal circumference by $\pm$ 12.6 days, suggesting that Abdominal circumference is the worst predictor for estimating gestational age.

CONCLUSION:

From this study it was concluded that fetal kidney length measurement is the most accurate method of determining gestational age than other fetal biometric indices like biparietal diameter,head circumference, abdominal circumference, femur length between 24 to 40 weeks of gestation.

Key words :

Gestational age , fetal kidney length,

CONTENTS

INTRODUCTION

INTRODUCTION

Accurate determination of the fetal gestation age and the expected date of delivery is fundamental and one of the most critical components of prenatal care, especially in high risk pregnancies. If the gestational age is not calculated accurately, it will lead to iatrogenic prematurity or postmaturity. It will increase perinatal morbidity and mortality.

Importance of accurate determination of Gestational Age:

- To schedule invasive procedures such as chorionic villi sampling and genetic amniocentesis.
- In interpretation of biochemical test like expanded maternal serum alpha –feto protein screening.
- To evaluate the fetal growth.
- To anticipate normal spontaneous delivery or to plan elective delivery within the time frame of a term pregnancy (38 to 42 wks).
- In some situations early termination of pregnancy is indicated as soon as fetus attains maturity.

  Eg., Severe preeclampsia, severe IUGR, etc.,

Gestational age influence the management decision of the fetus diagnosed with anomaly. So all important clinical decision is influenced by the gestational age.

Clinical dating using date of last menstrual period, uterine size, date of Quickening has limited value. Even women who conceived in the course of Infertility protocols may have a significant errors in the estimation of their EDDs. Therefore all pregnant women should have ultrasound examination for confirmation of their gestational age.

Ultrasound has become a vital tool in obstetrical examination and also in the accurate estimation of fetal gestational age. Ultrasound measurements of Gestational sac diameter and Crown rump length are more reliable in estimation of gestational age in first trimester.

In the second trimester BPD and Femur length are most commonly used. BPD and FL predict the gestational age more accurately in the early second trimester. However, as the gestational age progresses, they become increasingly unreliable because of biological variability of size in relation to age.

Number of studies conducted in the past shows linear co-relation between Fetal kidney length and gestational age. The present study is undertaken to validate the fetal kidney length measurement as an additional morphological measurement in estimation of gestational age.

Rule of Thumb is that

“Renal length in mm approximates Gestational age in weeks”.

AIMS AND OBJECTIVES

AIMS AND OBJECTIVES

- To evaluate the accuracy of fetal kidney length measurement in estimating gestational age.
- To compare its efficacy in estimating gestational age with other commonly used sonographic parameters like BPD, FL, HC and AC.
- To find out the most accurate parameter in estimating gestational age.

REVIEW OF LITERATURE

REVIEW OF LITERATURE

Methods for clinical estimation of GA and expected date of delivery:

1. Last menstrual period: (Naegele's formula)

The period of gestation is calculated by adding 280 days to the LMP, or by adding 9 months + 7 days or 40 weeks from the first day of LMP. It is difficult in some situations, when

i. The woman is having irregular menstrual cycle.

ii. If she forgot her last menstrual period, or reports wrongly.

iii. conception occurs during lactational amenorrhoea.

iv. If she had bleeding in early pregnancy.

2. Date of Positive urine pregnancy test :

Pregnancy can be confirmed 8 to 11 days after conception. If the test is positive after 4 to 5 weeks of amenorrhoea the patient's dates become firmly established. The test is not reliable after 12 weeks.

3. Bimanual pelvic examination:

Size of the uterus prior to 12 weeks more precisely corresponds with the period of amenorrhoea.

4. Date of Quickening :

It gives a rough idea of expected date of delivery. The expected date of delivery is calculated by adding 20 weeks in primi and 22 weeks in multi to the date of quickening .

5. Symphysio – fundal height:

From 24wks, the symphysio – fundal height in cm corresponds to the gestational age in wks upto 36 weeks. But it become unreliable in conditions like maternal obesity, multiple pregnancy, intra uterine growth restriction, diabetic pregnancy, inter & intra observer measurement variation.

Mc donald'srule :

Duration of pregnancy = height of fundus in cm x 2/7

(in lunar months)

Duration of pregnancy = height of fundus in cm x 8/9

(in weeks)

6. Auscultation of fetal heart sounds:

The date on which fetal heart sounds are first audible is used to determine gestational age.

Doppler ultrasound – 10 weeks

Obstetrics stethoscope – 18 to 20 weeks

7. Abdominalgirth :

The abdominal girth is measured in inches at the level of umbilicus. In a singleton pregnancy with a longitudinal lie, the girth in inches corresponds to the gestational age in weeks from 24 to 36 weeks.

8. Ultrasound measurement of fetal biometry:

CRL, BPD, AC, FL

Reliability of the expected date of delivery:

Excellent dates:

1. Patients with adequate clinical information (known, normal LMP,28-30 days cycles, no recent use of OCP, uterine size in agree with dates) and USG examination done between 16 and 24 weeks.
2. Patients with inadequate clinical information but with two USG Examinations done between 16 and 24 weeks showing linear fetal growth and similar EDD.

Good dates :

1. Patients with adequate clinical information and one confirming ultrasound examination obtained after 24 weeks of gestation.

2. Patients with inadequate or incomplete clinical information and 2 or more USG exams showing adequate growth and similar EDD.

Poor dates :

Patients with inadequate clinical information and no USG available.

ULTRASOUND IN OBSTETRICS

The ultrasound is a sound wave beyond the audible range of frequency greater than 2MHz(cycles per second). SONAR stands for "Sound Navigation and ranging." The clinical application of ultrasound in obstetrics was introduced and popularized by Ian Donald in glascow in 1958.

Ultrasound is produced by the vibration of synthetic piezoelectric Crystal in response to a rapidly altering electrical potential situated in the transducer of an ultra sound machine. The transducer converts electrical energy to mechanical energy (ultrasound) and vice versa. The commonly used frequency range in obstetrics is 3 to 5 MHz for abdominal transducers and 5 to 7 MHz for vaginal transducers. When the frequency increases there is improvement in image resolution but due to rapid wave attenuation, deeper structures are not properly visualized. In

medical imaging, the transducer both sends and receives ultrasound waves. Sound travels through the tissue of the body at 1540 meters per second.

The echo strength depends mainly on the following factors:

- Acoustic impedance mismatch.
- Angle at which the ultrasound beam strikes a reflecting interface.
- Strength of the ultrasound .
- Size of the reflector.

INDICATIONS FOR OBSTETRIC ULTRASOUND:

FETAL:

- Diagnosis of pregnancy
- Diagnosis of ectopic pregnancy
- Dating of gestational age
- Diagnosis of multiple pregnancy
- To confirm cardiac activity and fetal viability
- Detection of anomaly (structural/chromosomal)
- Assessment of growth (IUGR)

- Assessment of well being (biophysical profile)
- Diagnosis of presentation (breech, face)

UTERO PLACENTAL:

- Localization of placenta
- Diagnosis of abruption placenta
- Diagnosis of molar pregnancy
- Diagnosis of uterine malformations
- Assessment of liquor volume (polyhydramnios, oligohydramnios)
- Chorionicity in multiple pregnancy
- Diagnosis of cervical incompetence

MATERNAL:

- Pelvic mass diagnosis and follow-up
- Others: as an adjunct to obstetric intervention
- Amniocentesis, Chorion villous sampling, Cordocentesis
- Fetoscopy, Intrauterine fetal therapy
- External cephalic version

INSTRUMENTATION AND SCANNING TECHNIQUE:

There are three major types of ultrasound examinations in obstetrics.

These include,

i. Transabdominal sonography.

ii. Transvaginal sonography for early pregnancy,

iii. Doppler evaluations of the placental and fetal circulations.

Transabdominal Sonography:

Transabdominal real-time sonography forms the foundation for most obstetrical evaluations. This technique allows delineation of the fetus, uterus and adnexal areas. Transabdominal sonography is performed with a distended urinary bladder, so as to displace bowel loops out of the pelvis and provide an acoustic window for assessing the echogenicity of surrounding structures. Transabdominal sonography is usually performed with real-time transducers. The transducers can have various configurations, including multi-element linear array that is either electronically or phase activated, single element wobbler transducers and multiple rotating transducers. Each of these has specific ‘foot print’ and is therefore best utilized for certain specific applications. A curved linear multi-element transducer affords the best means for evaluation of the

obstetric patient in the second and third trimester since it allows a relatively large field of view compared to smaller sector transducer.

Transvaginal sonography:

Transvaginal sonography can be performed using a variety of transducers. These include a curved linear multi-element transducer, a single element mechanical sector transducer and a multi element phased array transducer. Transvagina lsonography can utilize higher frequencies than transabdominal sonography, since the region of interest is nearer to the probe, the resolution is better.

Doppler:

Doppler transducers can either be incorporated onto real time transducers or be 'out rigged' relative to the main transducer element. Doppler scanners can either image with continuous wave of range gated pulse imaging or power Doppler imaging. Doppler transducers are used for evaluation of fetal blood flow and have been incorporated in colour Doppler systems for visual, audio and spectral delineation of flow patterns in the fetus, placenta and uterus.

SAFETY OF ULTRASOUND:

Ultrasound is found to be safe for the growing fetus. There is no reported risk of ionizing radiations as in x-rays or embryo toxic effect.

The effects of ultrasound on tissues are temperature elevation, formation of microbubbles and cavitation. However, there is no clear evidence till date that ultrasound examination during pregnancy is harmful.

The current majority opinion is that 3 properly performed ultrasound examination are necessary for adequate pregnancy surveillance.

1st at the end of the first trimester,

- To establish gestational age accurately.
- Rule out multiple gestation.
- Screening for aneuploidy.

Second between 18 and 22 weeks,

- To establish gestational age.
- To diagnose fetal anomalies.
- Locate placenta.

Third after 32 weeks,

- To assess fetal growth .
- Locate placenta.
- Assess amount of amniotic fluid.

FETAL BIOMETRY

Estimation of gestational age using ultrasound has been tried with various parameters while the search for newer parameters continues, First trimester parameters are,

- Gestational sac- 5 weeks
- Gestational sac + fetal pole – 6 weeks
- Crown rump length -7 weeks

  CRL dates pregnancy with accuracy of $\pm$ 5 days

Second and third trimester parameters are,

- Biparietal diameter
- Abdominal circumference
- Head circumference
- Femur length,

These parameters dates pregnancy with accuracy of ,

$\pm$ 7 to 10 days in 2nd trimester,

$\pm$ 2 to 3 wks in 3rd trimester,

Along with these kidney length can be measured in the late 2nd& 3rd trimester scan and maturity of fetus can be confirmed.

Other fetal parameters :

- Transcerebellar diameter
- Trans coelomic diameter
- Floating particles in amniotic fluid
- Length of long bones
- Orbit & lens dimensions, Fetal binocular distance
- Clavicle length, Foot length
- Fetal liver
- Fetal scapula, sacral length
- Fractional spine length,
- Fetal ear length, fetal nasal bones.

FIRST TRIMESTER DATING:

Gestational sac:

The gestation sac is demonstrated as a circular echo free area enclosed by a reflective ring within the uterine cavity. It is visible from 5 to 6 weeks postmenstrual age by transabdominal scanning or week earlier using transvaginal Scanning. Mean sac diameter (MSD) provides an estimation of gestational age in a normally developing pregnancy. MSD is the average internal diameter of the gestational sac, calculated as the

mean of the AP, transverse and longitudinal diameter. MSD increases about 1mm per day in early gestation.

Gestational age: MSD + 30 days.

Gestational sac volume (GSV) (ml3): L (cm)xAP (cm) x T (cm) x 0.5

An embryo and cardiac activity should always be visible when the GSV is 2.5 ml or more. The MSD measurement between 2 and 14 mm (i.e. before the embryo can be seen) are highly reliable. The accuracy of MSD measurements deteriorates after this time.

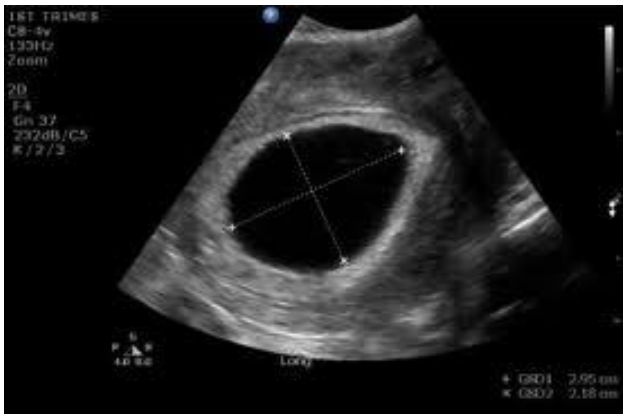


Figure 1: Gestational sac

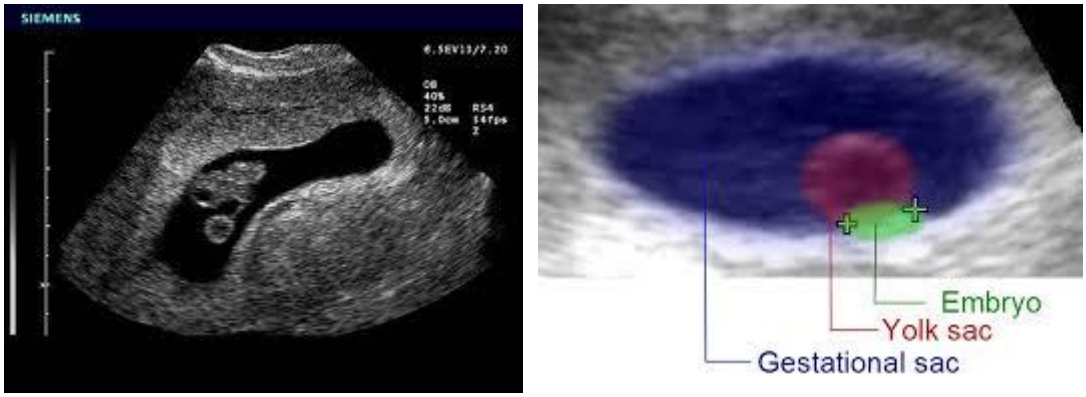


Figure 2: Gestational sac, Embryo and Yolk sac:

Crown rump length (CRL) :

Once the embryo can be visualized the measurement of choice for estimation of gestational age becomes the CRL. The developing embryo can be consistently detected with transvaginal transducer when the CRL reaches 5 mm or MSD equals approximately 14 mm. By 6th gestational week early embryo and cardiac activity can be identified.

The CRL is the length of the foetus from the top of its head to the bottom of its torso. It is measured as the longest dimension of the embryo, excluding the yolk sac and the extremities. The accuracy of CRL in predicting gestational age was 3 to 5 days (+/- 2 SD).

After 12 to 13 weeks gestation, the CRL becomes less reliable because t it is affected by foetal position, measuring shorter in a foetus whose spine is flexed and longer in foetus whose spine is extended.

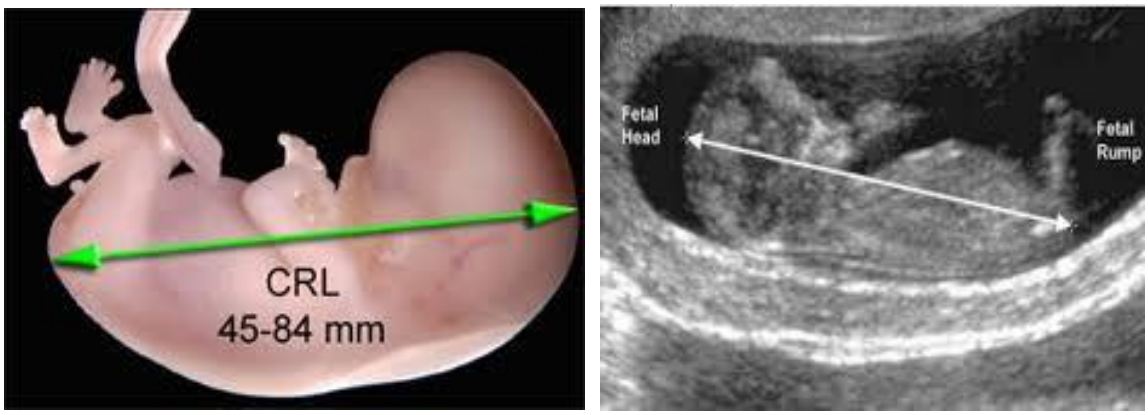


Figure 3: Crown rump length

SECOND TRIMESTER DATING:

Bi parietal Diameter (BPD):

Its accuracy is maximal between12 to 20 weeks of gestation (Campbell et al 1971). It has become an established method of assessing gestational age as it is easy to obtain. A single optimal measurement would predict gestational age within ± 5 days.BPD is the maximal diameter of a transverse section of the fetal skull at the level of the parietal eminences.

A correct section should include the following:

- The Falx cerebri.
- The cavum septum pellucidum.
- The thalami
- The basal cisterns.

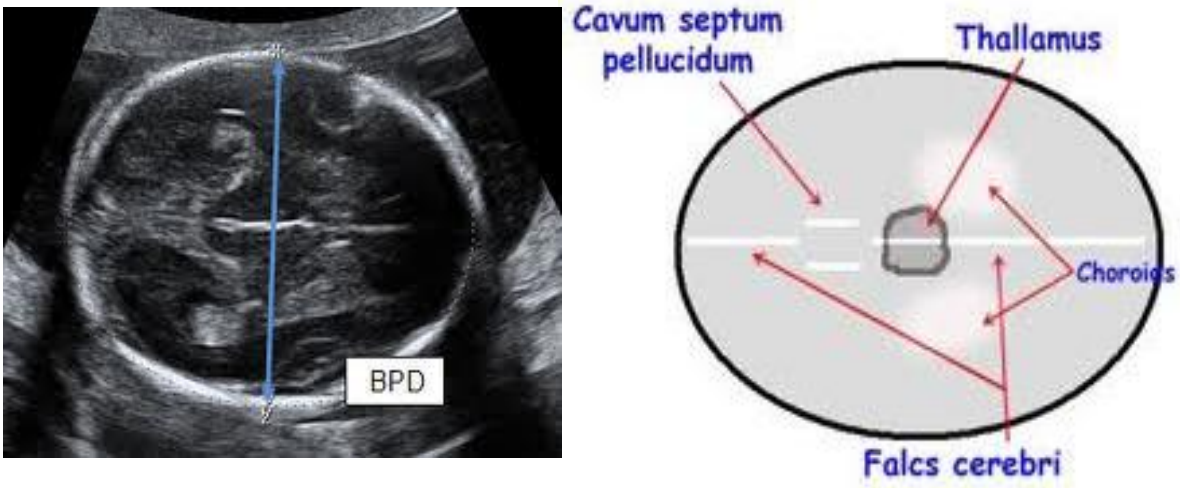


Figure 4: Biparietal diameter (BPD)

After assessing the ovoid shape of the fetal skull BPD is measured on a frozen image. Horizontal component of the first caliper is placed on the outer aspect of the proximal surface and the second caliper is placed on the inner aspect of the distal skull surface at right angels to the midline and at the widest diameter. The BPD is measured from outer to inner skull tables. (P. Chudleigh and J.M. Pearce in 1992). (Shepard and Filly 1982; Hadlock et al 1982)

Drawbacks: (P.Chudleigh and J.M.Pearce 1992).

- In the second half of pregnancy, BPD obtained from the fetus presenting as breech or transverse may be unreliable. In these the fetal head may appear dolichocephalic (long and narrow). This produces a measurement that could be small for gestational age.
- Measurement of the BPD can only be obtained in the occipito transverse position as the landmarks are better recognized when the midline echo is at 90 degrees to fetal head than when the head is direct occipito posterior, direct occipito anterior or deep in the maternal pelvis.
- If the angle of asynclitism is incorrect, the midline echo does not lie centrally with in the fetal skull.

- The fetal skull will appear too round if the rotation of the fetal head is incorrect.
- Incorrect levels due to the sliding movements will alter the level of the section.

Head circumference :

Head circumference is one of the most reliable individual parameters for estimation of gestational age.

The rule for measuring the HC are as follows :

- Plane of section through the third ventricle and thalami.
- Cavum septi pellucidi must be visible in the anterior portion of the brain.
- The tentorial hiatus must be visible in the posterior portion of the brain.
- Cursors are positioned at the outer edge of the near calvarial wall and the outer edge of the far calvarial wall. Alternatively it can be calculated from the outer edge to outer edge analogs of the BPD and OFD.

  HC: 1.57 x [(outer to outer BPD) + (outer to outer OFD)].

HC is superior to the BPD as a predictor to gestational age. The variability of predicting the gestational age from HC is within +/- 1 week before 20 weeks gestation and increases progressively throughout pregnancy reaching a peak of approximately +/- 3.8 weeks in the late third trimester.

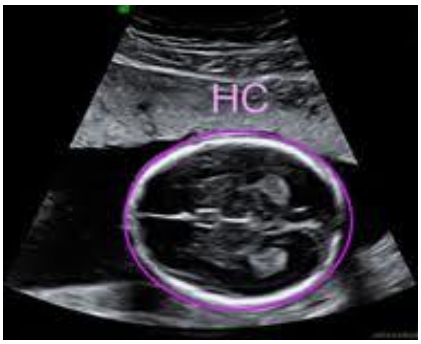


Figure 5 : Head circumference.

Femur Length (FL):

FL was originally measured to diagnose limb dwarfism. It was subsequently observed that femur length can be used to determine the fetal gestational age. The femur can be measured from 10 weeks onwards. (Hohler & Quetel in1982, Hadlock et al. in 1982 and Jeanty et al. in 1984).

This measurement is as accurate as BPD in the prediction of gestational age. It is useful in confirming the gestational age estimated from BPD measurements and often be obtained when fetal position prevents measurements of the BPD. (P. Chudleigh and J.M. Pearce in 1992).

Method:

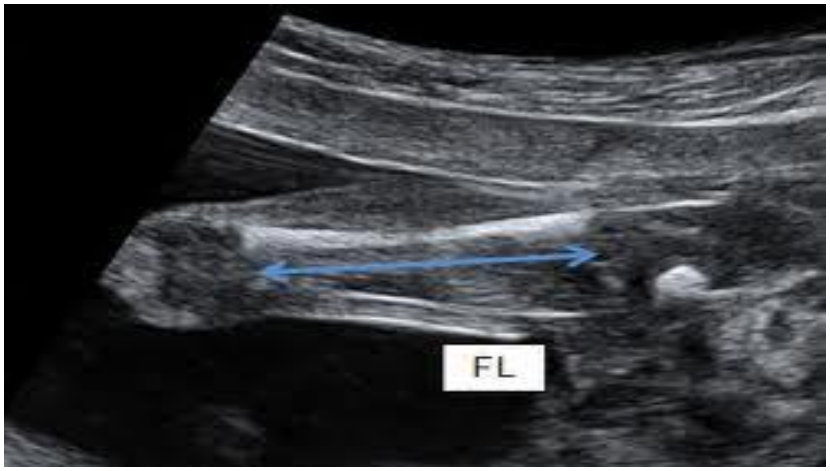


Figure 5: Femur length

The transverse section of the fetal abdomen is found and the transducer should be slide caudally until the iliac bones are visualized. At this point, a cross section of the femur is usually seen. By keeping this bright echo from the femur in view, the transducer is rotated until the full length of the femur is obtained. The soft tissue should be visible beyond both the ends of the thigh at any point. The measurement of the femur is made from the centre of the 'U' shape at each end of the bone. This represents the length of the metaphysis. (P. Chudleigh and J.M. Pearce in1992).

Problems :

The gestational age calculated from measurements of FL and the BPD should be similar. If the FL is small compared to the BPD,we

should measure all the long bones to exclude dwarfism. (P. Chudleigh andJ.M. Pearce in 1992).

Among the other long bones, measurement of the humerus is preferred. Next Comes the tibia, the radius and the ulna are used only when confusing results are obtained. (Jeanty P.et al. in 1984).

Abdominal Circumference (AC)

Method :

A longitudinal view of the fetus that demonstrates both the fetal heart and the fetal bladder should be obtained. The transducer should be slide laterally until the fetal aorta is visualized in the course through both the fetal chest and the abdomen. The transducer is rotated through 90 degrees at the level of the fetal stomach to obtain a cross section. The image should be frozen at the correct level (P. Chudleigh and J.M. Pearce in 1992).

- The outline should be circular.
- A short length of intrahepatic part of the umbilical vein should be imaged so that, it is centrally placed between the lateral abdominal walls and is a third of the way along an imaginary line drawn from the anterior abdominal wall to the fetal spine.

- The stomach is usually visualized as a transonic area in the left side of the abdomen.
- Vertebra is visualized in a cross sectional view in triangular form.

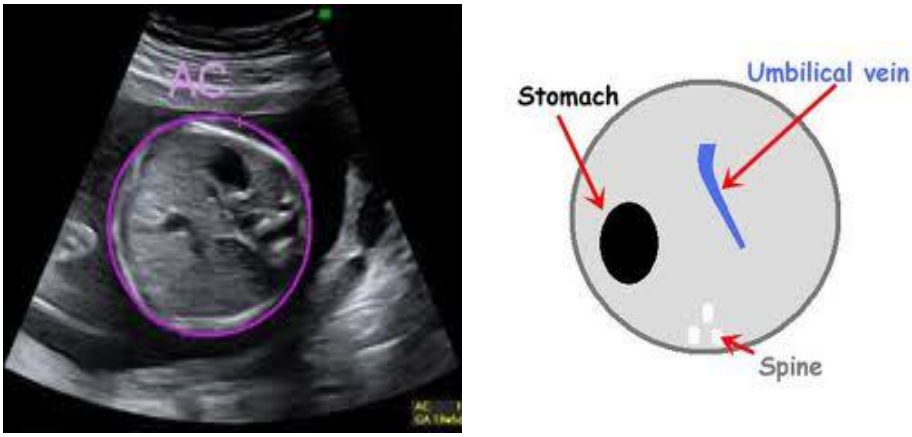


Figure 6: Abdominal circumference

The Ellipse Method :

The first on-screen cursor is placed on the outer table of the abdomen at the spine.The second cursor is then placed on the outer table of the abdomen at the anterior Abdominalwall. Using appropriate control, a ready formed ellipse of dots is moved out from between the two cursors until it matches the outline of the fetal abdomen.

Problems:

- Directly anterior fetal spine: When the fetal spine is directly anterior, it may not be possible to visualize the aorta.

- In the transverse section, the umbilical vein will not be seen, as it lies in the acoustic shadow produced from the fetal spine.
- Non-circular outline: A fetal limb can indent the outline.
- Late pregnancy: In late pregnancy, it is often not possible to fit the entire outline on the screen. It is better not to use the underestimate that will be obtained if an incomplete section is traced (P. Chudleigh and J.M. Pearce in 1992).

Adrenal gland

The thickness of the adrenal gland is measured (Jeantly P. et al. in 1984). Fetal adrenal gland measurement in longitudinal axis show linear progressive growth between 12and 17 weeks of gestation (Bronshtein M. et al. in 1993).

Spleen

The spleen volume is estimated using the formula of the ellipsoid. Spleen volume = longitudinal X transverse diameter X 0.5233(Schmidt et al).

Enough studies have not yet been done on the above abdominal parameters like adrenals and spleen to substantiate the findings and to use those as routine screening parameters.

The binocular distance is also one among the parameters suggested for the Estimation of gestational age. (Jeanty P. et al. in 1984).

Normograms have been obtained for various fetal parameters by various investigators. But these are not used widely. They are the lateral ventricle and hemispheric width(Denkhaus H. et al. in 1979), cerebellum, ear, liver, humerus, ulna, tibia, fibula, clavicle, foot, sacrum, inner orbital and outer orbital distances.

EMBRYOLOGY OF KIDNEY:

PHASES OF DEVELOPMENT:

The development of the kidney proceeds through a series of successive phases,

Pronephros : most immature form ,Rudimentary & Nonfunctional.

Mesonephros: functioning for a short period during early fetal life.

Metanephros : most developed form , definitive adult kidney.

Pronephros :

The pronephros starts developing at the end of 3rdweek . In the cervical region they develops as solid groups of cells numbering 7 to 10.The cloaca receives the tubules from the pronephros through excretory ducts. The entire groups form vestigial excretory units. They regresses

before the formation of mesonephros.The entire pronephric system disappears by the end of 4^{th} week.

Mesonephros :

The mesonephros and mesonephric ducts are developed from intermediate mesoderm from the upper Thoracic to Lumbar (L3) segments . The first excretory tubules of the mesonephric system appears during the fourth week of development , at the same time the pronephric system starts regressing . These tubules leghthen to form S – shaped loop.Tuft of capillaries form at one end of the tube to form glomerulus.

Around the glomerulus the tubules form Bownman's capsule. Laterally the tubules enters the longitudinal collecting duct known as the mesonephric or Wolffian duct. In the middle of the second month the mesonephros forms a large ovoid organ on each side of the midline. Since the developing gonad is on its medial side, the ridge formed by both organs is known as the urogenital ridge.

While caudal tubules are still differentiating, cranial tubules and glomeruli show degenerative changes . By the end of the second month, the majority have disappeared.

Metanephros :

The third urinary organ , the metanephros or permanent kidney appears during the fifth week. Collecting ducts of the permanent kidney develop from the ureteric bud. The bud penetrates the metanephric tissue, which is molded over its distal end as a cap. Subsequently the bud dilates, forming the primitive renal pelvis. The bud splits further to form major and minor calyces. The ureteric bud gives rise to the ureter, the renal pelvis, the major and minor calyces, and approximately 1 to 3 million collecting tubules.

The excretory units develop from metanephric mesoderm. Under the influence of the collecting tubule the cells of the tissue cap form small vesicles, the renal vesicles. S shaped tubules form from these vesicles, capillaries grow into the pocket at one end of the S and differentiate into glomeruli. These tubules, together with their glomeruli, form nephrons, or excretory units.

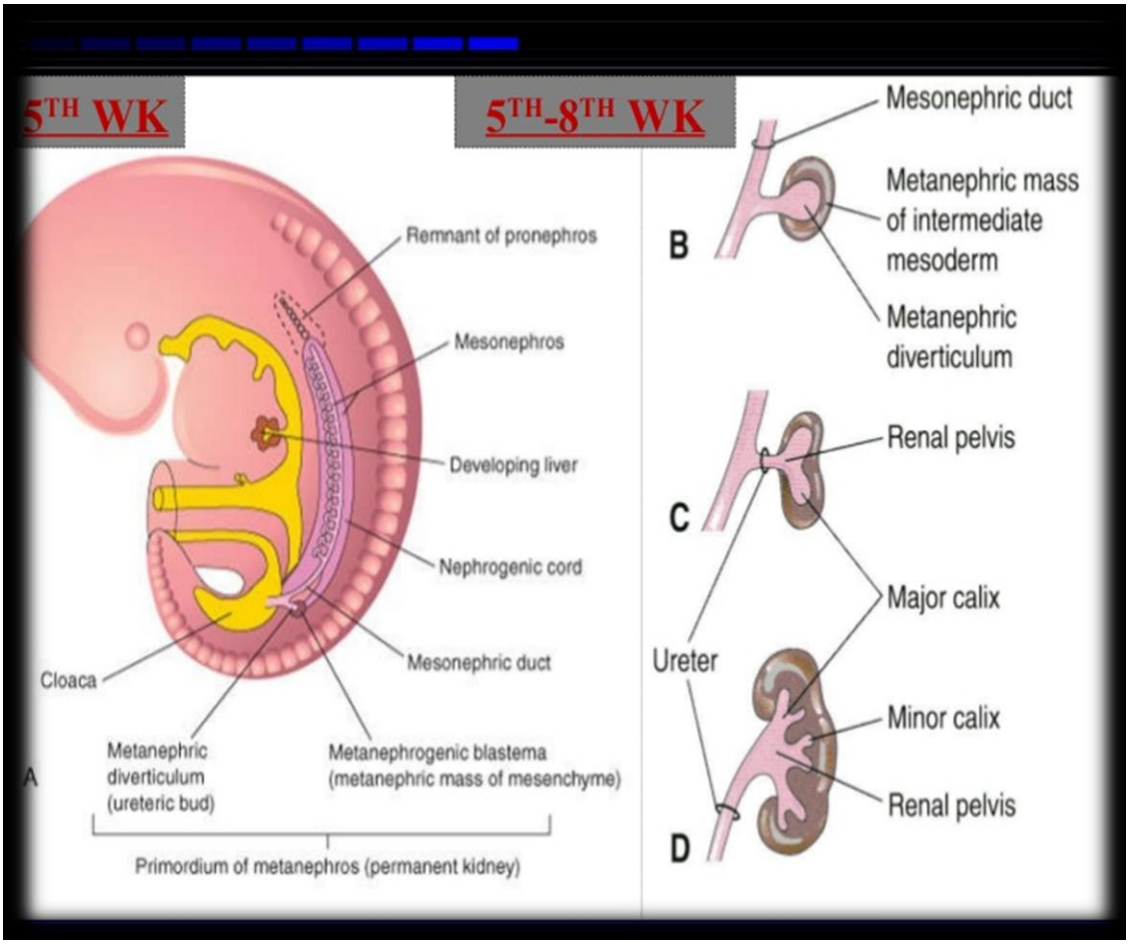


Figure 9 : Development of kidney

ASCENT OF THE KIDNEY:

The kidney "ascends" from its initial location in the pelvis (adjacent to the developing bladder) to its final location in the upper retroperitoneum(just caudal to the diaphragm) . It is caused by diminution of body curvature and by growth of the body in the lumbar and sacral region . During the ascent of kidney multiple transient blood vessels develops and degenerate. These arteries persist in ectopic

kidneys.The kidneys rotate around their vertical and horizontal axis so that their final orientation is one in which the upper poles are slightly more medial and anterior than the lower poles. As a result of rotation the renal pelvis lies medially and the renal parenchyma lies lateral to it.

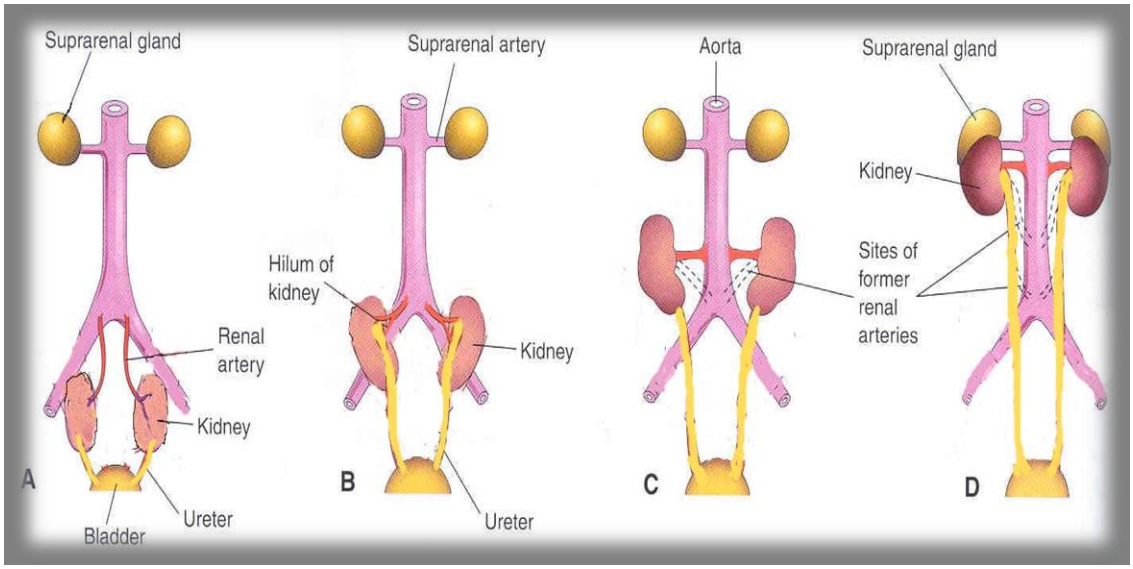


Figure 10 :Ascend of kidney

7th week of gestation	Development of kidney occurs in the fetal pelvis.
10thweek	formation of Nephrons
11th week of gestation	Ascend into the posterolateralretroperitoneum.
13-15thweek	kidneys start functioning and produce urine

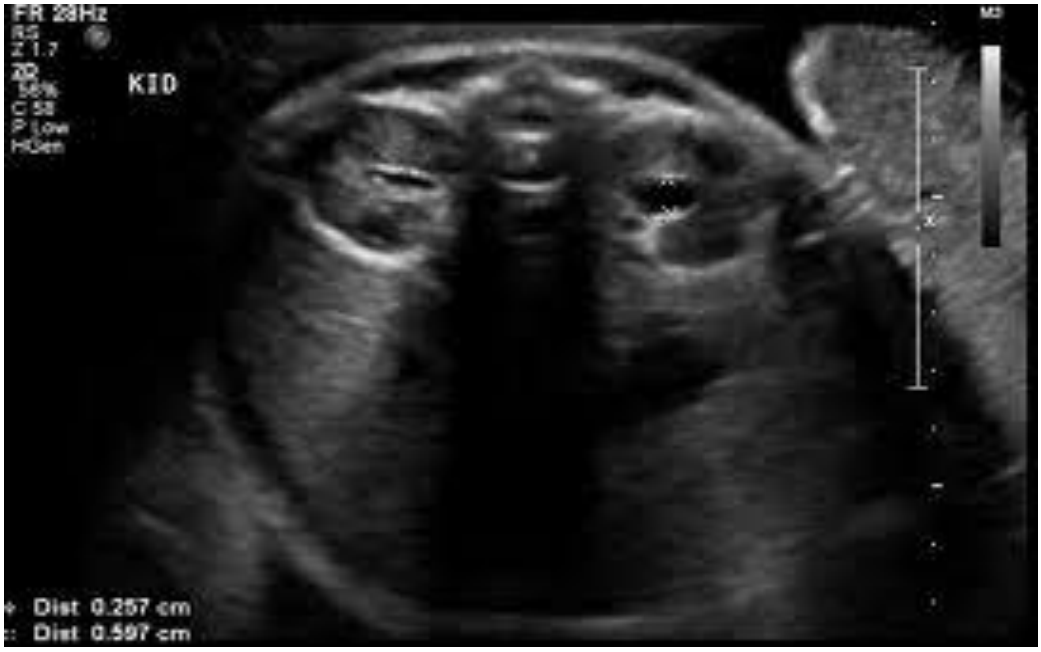


Figure 7:coronal view of kidney

Figure 8:Sagittal view of kidney

Gonzales J. et al.1976 Studied the growth rate of the kidney both in length and width during the last three months of pregnancy. This is the first study to correlate fetal kidney parameters with gestational age. The study was done by examining 390 anatomical specimens in the gestational age between 26-41 weeks. The study concluded that even in IUGR fetuses the measurement of kidney length correlates with the GA of the fetus. The result showed that size and weight of kidney increase with increase in duration of pregnancy.

Grannum p et al. in 1980, studied the changes in fetal kidney length with gestational age. 89 antenatal women without any risk for renal disease were included for study. The kidney length was measured from 12 weeks till term , they found that kidney length increases linearly till term.

Lawson et al. in 1981, Studied the ultrasound appearance fetal kidneys and its size and growth in different stages of pregnancy. In this study fetal renal diameter was measured with calipers in an antero-posterior direction on the axial images whenever the kidney could be identified. Renal length was measured on the coronal or sagittal views. When both kidneys were identified on the same image, the measurements were averaged. To document the accuracy of the observation and measurements, the authors sectioned 14 stillborn premature infants in

axial, coronal or sagittal plane and fetal anatomical relationships were studied and renal length and width were measured directly from the cut sections using a centimeter ruler.

Age was estimated from the hospital record and measurements of BPD, head circumference and crown heel length. The fetal kidneys appeared ultrasonographically as hypoechogenic circular structures, surrounding the strongly echogenic pyelocalyceal system. From 15-17 weeks, the kidneys were seen in less than half of the fetuses evaluated. One or both the kidneys were identified in 90% of cases from 17-22weeks and in 95% of cases after 22 weeks. Continued non-visualization after 22 weeks occurred in 5 cases.

Speigl G. et al.1982, studied the ultrasound measurements of fetal kidney growth in several patients and a growth rate was published .

Jeanty P. et al. in 1982, Studied the fetal kidney growth measurements using ultrasound before the publication by SpieglG. The kidneys appear as hypoechogenic oval structures in the middle of the posterior abdomen at 20 weeks.At 27th week, the capsule and renal pyramids appear as a distinct structure. The length of the kidney was measured from upper pole to lower pole. The width of the kidneys measured in the transverse section of the fetus. It was obtained at the height of the renal pelvis, or at the position where the renal section was

large visually. Caliper positioning could be very difficult due to the low contrast between renal parenchyma and the surrounding tissues. When difficulty was present, respiratory motions were extremely helpful in defining the cleavage plane between kidney and adjacent tissues. The width was not measured exactly perpendicular to the length.

The equation for **volume of kidney:**

Volume = length x width x thickness x 0.5233

The kidney which is proximal to the transducer was measured. Because the contour of the contralateral kidney will be hidden by spine shadow. Measurements were made without prior knowledge of the gestational age. They concluded that volume was the parameter that correlated well with gestational age and BPD. The results were well comparable with those of Lawson et al. and with those of Gonzales obtained from stillborns.

Bertagnoli L. et al. in 1983, Studied the changes in the antero-posterior diameter and length of the fetal kidneys according to gestational age.280 pregnant women in the gestational age between 22-40 were examined. statistical analysis was done . cross-sectional and longitudinal studies of kidney growth were performed to assess the correlation of the antero-posterior diameter and length of the fetal kidney to the gestational

age.From the results they concluded that fetal kidney measurements can be used as an additional parameter in the routine antenatal assessment of fetal well being and to rule out anomalies of kidney characterized by changes in kidney size.

Bowie JD et al in 1983, Studied the changes in the ultrasound appearance of fetal kidneys during pregnancy.100 women between 11 to 40 weeks of pregnancy were selected for study. The kidneys were never visualized in the first trimester. They were seen between 15 and 26 weeks but with difficulty. Due to deposition of fat in the para renal space and in the renal sinus the echogenicity increased in the late third trimester.

Callen et al. in 1985, studied the ultrasound measurement of average kidney diameter and BPD , and the ratio between the two in normal and fetuses with anomalous kidney. The study result shows that the ratio was constant in normal fetus and different in fetus with urinary tract pathology.

Sagi J. etal in 1987, studied the fetal kidney size in relation to gestational age. The study was done in 660 apparently normal fetuses. They concluded that fetal kidney size shows a linear correlation with gestational age .

Sampaio FJ. Et al. in 1990, did the study of the fetal kidney lengths growth during the second and third trimesters of gestation. Study was done in 120 human fetuses between 10 to 36 weeks of gestation. The longitudinal length of each kidney was measured and compared with gestational age .The growth rate of each kidney, in male and female fetuses were studied.The study result showed that fetal kidney length measurement can be used for estimation of gestational age and detection of renal anomalies.

In 1991, Cohen et al. studied the ultrasound measurement of fetal kidney length in 397 fetuses from 18 to 41 wks of pregnancy. The study included only normal fetuses, and the gestational age was estimated using LMP and fetal biometry. The mean fetal kidney lengths were found to be greater when compared to previous study . According to this study, strong correlation existed between fetal kidney length measurement and gestational age estimated by fetal biometry (biparietal diameter, femoral length, and abdominal circumference, and an average of the three). The study concluded that there is no correlation between height and weight of the parents and fetal kidney length. The study also concluded that there no significant difference between the Right and Left kidney lengths.

In 1995 Rose PG measured the fetal kidneys with ultrasonographic scans. The studywas done to establish a normal range of measurements

for the external and internal dimensions of the fetal kidney and if possible, to correlate these measurements with gestational age. The measurements were studied in 810 women. Postnatal data was also obtained from medical records of newborns. The maximum of pairs of renal measurements were used for analysis. Measurements were cross-sectional in 347 cases and longitudinal in 463. They found that the external renal dimension and gestational age were closely related enabling accurate growth centile charts to be constructed. The correlation between renal pelvic dimensions and gestational age was weak. The conclusion was it was possible to assess the growth and size of the fetal kidney according to gestational age but this did not apply to the renal pelvis. A renal pelvic dimension of > 5 mm at any gestational age was unusual.

Gloor JM et al. in 1997, studied the ultrasound evaluation of fetal renal growth, fetal body weight according to gestational age. Prenatal ultrasound were performed in 100 pregnant women between 18 and 39 weeks of gestation. Fetal renal length and volume were determined and compared with gestational age and estimated fetal body weight.The study result showed that the fetal body weight, the renal length and renal volume increased throughout gestation and the ratio between renal volume and body weight remained constant.

Ansari SM et al in 1997, in Bangladesh, studied the ultrasound measurement of normal fetal kidney lengths of fetuses between16 and 40 weeks of gestation. In this study, 793 fetuses were included.They found that the average length of the kidney at term (3.95 cm) was same as previous studies. The kidney length measurement correlated well with other parameters in gestational age estimation.

Konje JC et al in 1997, Studied the differences in the fetal kidney measurements between normal and small for gestational age fetuses at different gestational age . 219 singleton fetuses from 22 to 38 weeks of gestation were studied. The fetal kidney length, circumference and antero-pesterior and transverse diameters were measured at each gestational age. The fetuses were classified as small or appropriate for gestational age, depending on the birth weight. The various kidney measurements for the two groups were compared. The circumference, transverse and anteroposterior diameters were greater for normal fetuses when compared with small for gestational age fetusus.

The differences in fetal kidney size with gestation start manifesting from 26 to28weeks. The kidney length measurement in both groups at various gestational ages were similar. They concluded that fetal kidney length measurement correlated well with the gestational age both in small and appropriate for gestational age fetuses.

Kiran Pandey et al. in 2001, studied the correlation of fetal parameters kidney lengths, kidney circumference, BPD, FL, AC, HC with gestational age. The study result showed that kidney length and kidney circumference correlated well with the gestational age, with the correlation coefficient of r= 0.84 and o.86. They predict the gestational age with the standard error of 1.51 weeks . other parameters (BPD,HC,FL,AC) predicts gestational age with the standard error of 3 weeks.

Konje JC et al. in 2002, studied gestational age determination by measuring fetal kidney length after 24th week of gestation.73 pregnant women with uncomplicated pregnancies were selected for the study. Serial measurement of fetal biometry and kidney length were done from 24 to 38 weeks of gestation with a interval of 2 weeks. Using this gestational age was calculated and compared with crown-rump length(taken between 8-10 weeks of gestation) dating. Linear regression analysis was done. The results showed that FL and fetal kidney length are the best parameters for determination of gestationalage (+10.29 and 10.96 days respectively). They concluded that fetal kidney length measurement was a more accurate method of estimating gestational age than other fetal biometric indices like BPD, HC, AC, FL.

Lampl et al in 2002, studied the correlation of fetal kidney measurements at late gestational weeks (after 24 weeks) with weight and ponderal index at birth. 25 normally growing fetuses were taken as sample . They found that fetal weight and kidney volume at 32 weeks were positively related to both ponderal index and weight at birth.

Nahid yusuf et al in 2007 studied the correlation of fetal kidney length with gestational age . The study included 102 pregnant women after 30 weeks of gestation. All the patients had dating scan done at early weeks of pregnancy . The fetal kidney length measurement showed a linear correlation with gestational age . The mean fetal kidney length in mm corresponds to gestational age in weeks. The result concluded that measurement of fetal kidney length can be used as an additional parameter for the estimation of gestational age.

J JKausaria et al in 2009, done a study in 70 antenatal women with excellent dates. Fetal biometry (BPD, HC,AC, FL) along with fetal kidney length were measured serialy between 22 -38 weeks of gestation with a interval of 2 weeks. They concluded that fetal kidney length predicted gestational age with better precision than other biometric indices.

MATERIALS AND METHODS

MATERIALS AND METHODS

The study was carried out in the department of Obstetrics and Gynaecology in Chengalpattu Medical College Hospital during the period of November 2012 to October 2013.

200 pregnant women with singleton pregnancy without any complication were selected for the study. Patients selected were booked cases in the same institution and are those who are reliably sure of the date of their last menstrual period. The patients were evaluated as per the history, general physical examination, Antenatal examination and routine antenatal investigations.

Following this, using ultrasound mean kidney length along with fetal head circumference, biparietal diameter, femur length, and abdominal circumference were measured. Gestational age was calculated from all these parameters. These values were then compared with actual gestational age derived from excellent dates taken as a standard.

INCLUSION CRITERIA:

- Women with regular menstrual cycle.
- Women who are certain of their LMP.
- Women whose pregnancies are accurately dated by first trimester ultrasound.

- Women with singleton gestation.

EXCLUSION CRITERIA:

- Women with irregular menstrual cycles.
- Women with unknown or inaccurate date of last menstrual period.
- Multiple gestation.
- IUGR, oligohydramnios, polyhydramnios, or suspected

  Fetal anomalies.
- Gross maternal obesity.
- Fetus with abnormal adrenal or renal morphology and renal pelvic dilatation more than 5mm.
- Women with other risk factors like anaemia, hypertension, GDM, heart disease, epilepsy, thyroid disorders, jaundice and autoimmune disorders.

EXAMINATION METHOD:

Detailed history regarding LMP, regularity of flow, recent use of OCP, date of urine pregnancy test done, earliest scan, date of quickening was obtained to confirm the gestational age.

The registered women were subjected to routine antenatal examination. Height and weight of the women, blood pressure were

measured. Obstetric examination including symphysiofundal height was measured. Routine investigation was carried out as per hospital protocol .

The women were underwent standard ultrasound Fetal biometry and Fetal kidney length measurement. These measurements has been used to date the pregnancies.

Comparison has been made between the accuracy of fetal kidney length measurement and other fetal biometric parameters (BPD, HC, AC, FL) in the determination of gestational age.

Informed written consent was taken from all involved patients.

The length of fetal kidney is a bipolar measurement using gray scale real time ultrasonographic scanner with 3.5 ~ 5.0 MHz transducer. Measurements are obtained in the sagittal plane, when full length of kidney with renal pelvis is visualized.

Figure 11: The ultrasound machine used in my study is LOGIQ C2.

STATISTICAL ANALYSIS:

- Linear regression models for estimation of gestational age are derived from the biometric indices and kidney length.
- Comparisons have been made between the accuracy of these models in the determination of gestational age.
- Person correlation has been perfomed to find the relationship between variables.
- Statistical significance was considered to be achieved at P-values < 0.05.
- Data was analyzed using MS-Excel 2007.

RESULTS AND ANALYSIS

RESULTS AND ANALYSIS

200 Patients booked at Chengalpattu Medical College Hospital ante natal clinic with a dating scan and regular menstrual cycles were selected for the study.

Along with routine antenatal investigations as per hospital protocol, ultrasound scan was done after 24 weeks of gestation to determine gestational age using fetal biometric indices, viz.,

BPD, HC, FL, AC

Along with these, kidney length (KL) was determined for our study. The results were analyzed with respect to age and parity of the patients.

TABLE 1 :

Frequency distribution of the cases according to their age in years:

Age distribution	Number of cases	Percentage
<=19	16	8%
20-29	171	85.5%
30-34	11	5.5%
>=35	2	1%

This table shows the age distribution of patients in this study. The cases were in the age group of 18 to 37 yrs.

- 85.5% of women were in the age group of 20 to 29 years.
- 1% was above 35 years.
- 8% of women belonged to the teenage group.

This study showed, that the age of antenatal women had no significant correlation with the renal length in assessment of gestational age.

Diagram 1:

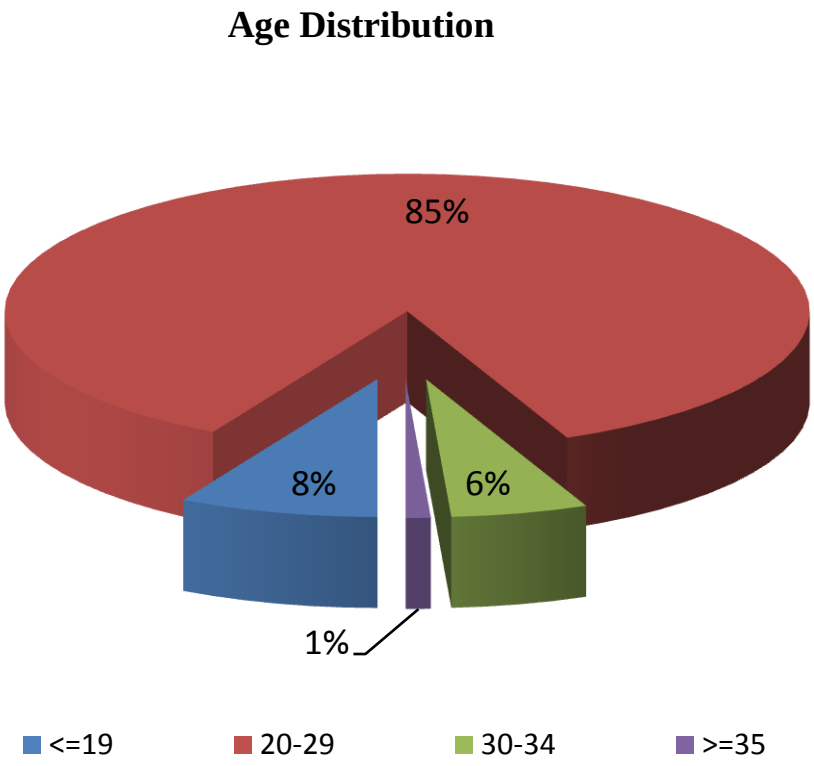


TABLE 2:

Frequency distribution table of the cases according to their parity:

Parity	No of Cases	Percentage
Primi	94	47%
Multi	106	53%

This table shows the parity distribution of the study group,

- 53% were multiparous.
- 47% were primi.

Our study shows that parity did not alter the kidney length of fetus belonging to the same gestational age.

Diagram 2:

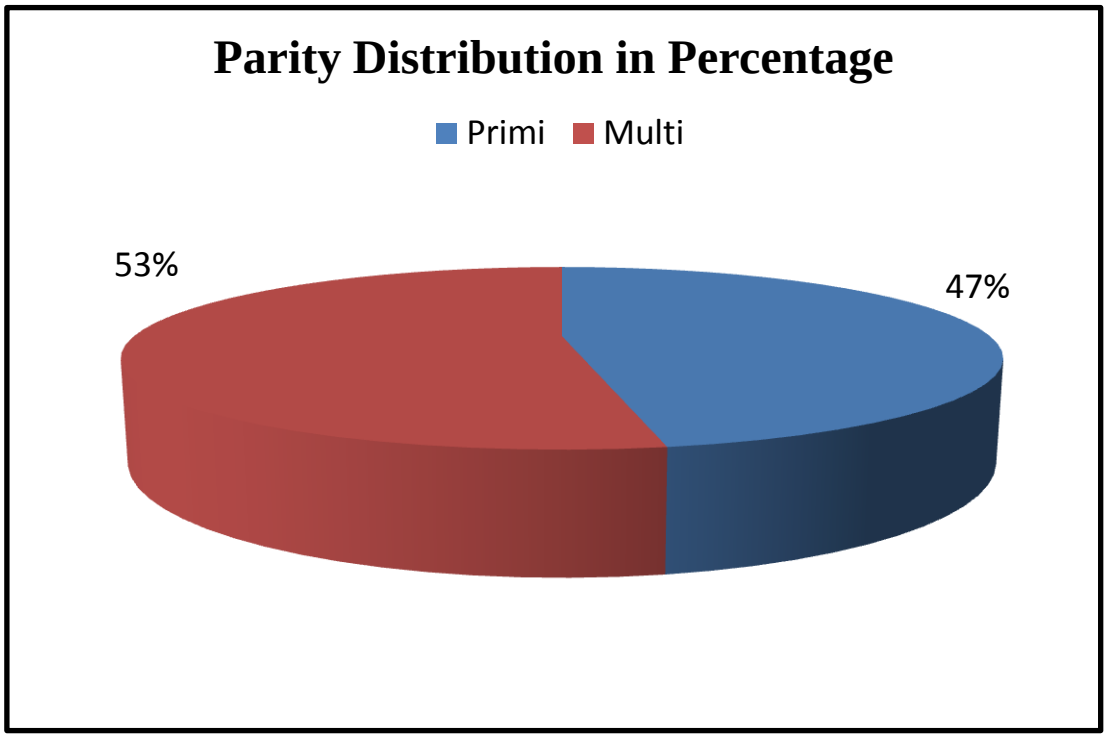


TABLE 3 :

The trimester distribution of the 200 pregnant women included in this study is as follows:

II TRIMESTER	III TRIMESTER
49	151

This table shows the trimester distribution of study group

- 24% of study group were in 2nd trimester.
- 76% of study group were in 3rd trimester.

Diagram 3 :

TRIMESTER DISTRIBUTION

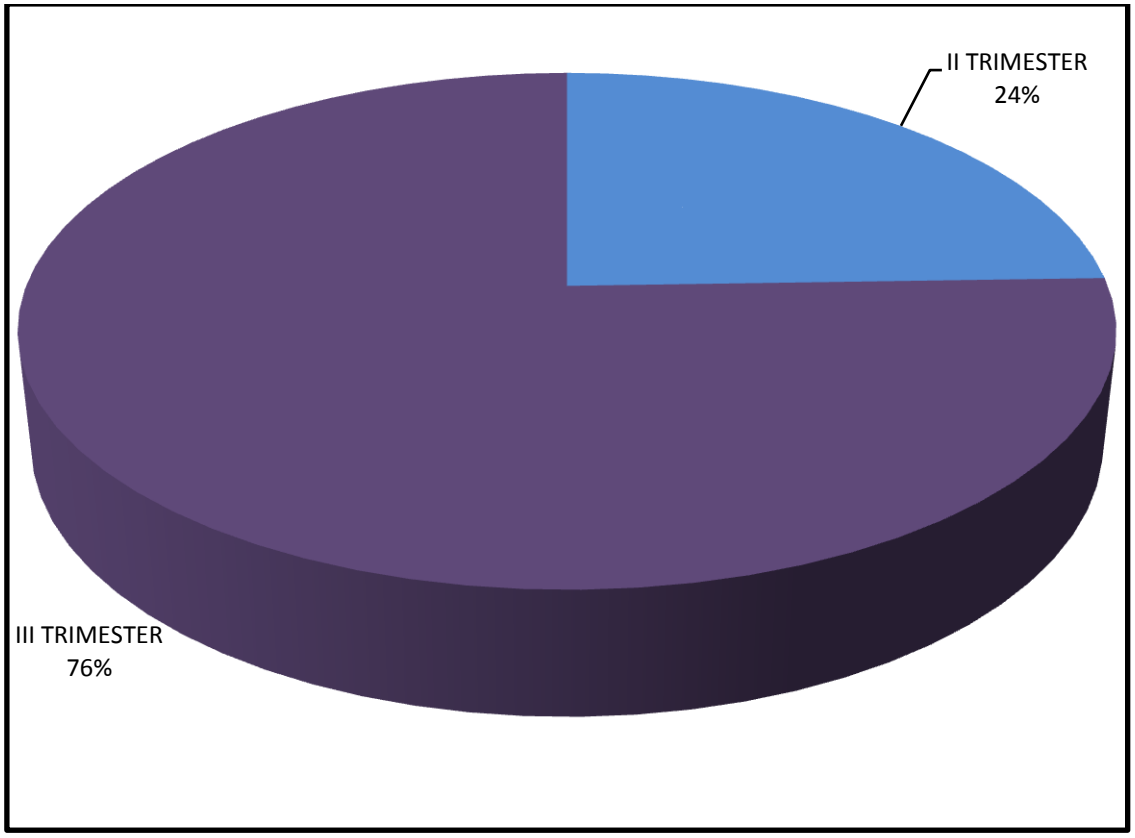


TABLE 4:

DISTRIBUTION OF NUMBER OF CASES IN EACH GA:

Gestational age in weeks	No of cases	Percentage (%)
24	11	5.5
25	6	3
26	8	4
27	9	4.5
28	15	7.5
29	5	2.5
30	9	4.5
31	11	5.5
32	17	8.5
33	9	4.5
34	17	8.5
35	17	8.5
36	30	15
37	17	8.5
38	9	4.5
39	6	3
40	4	2

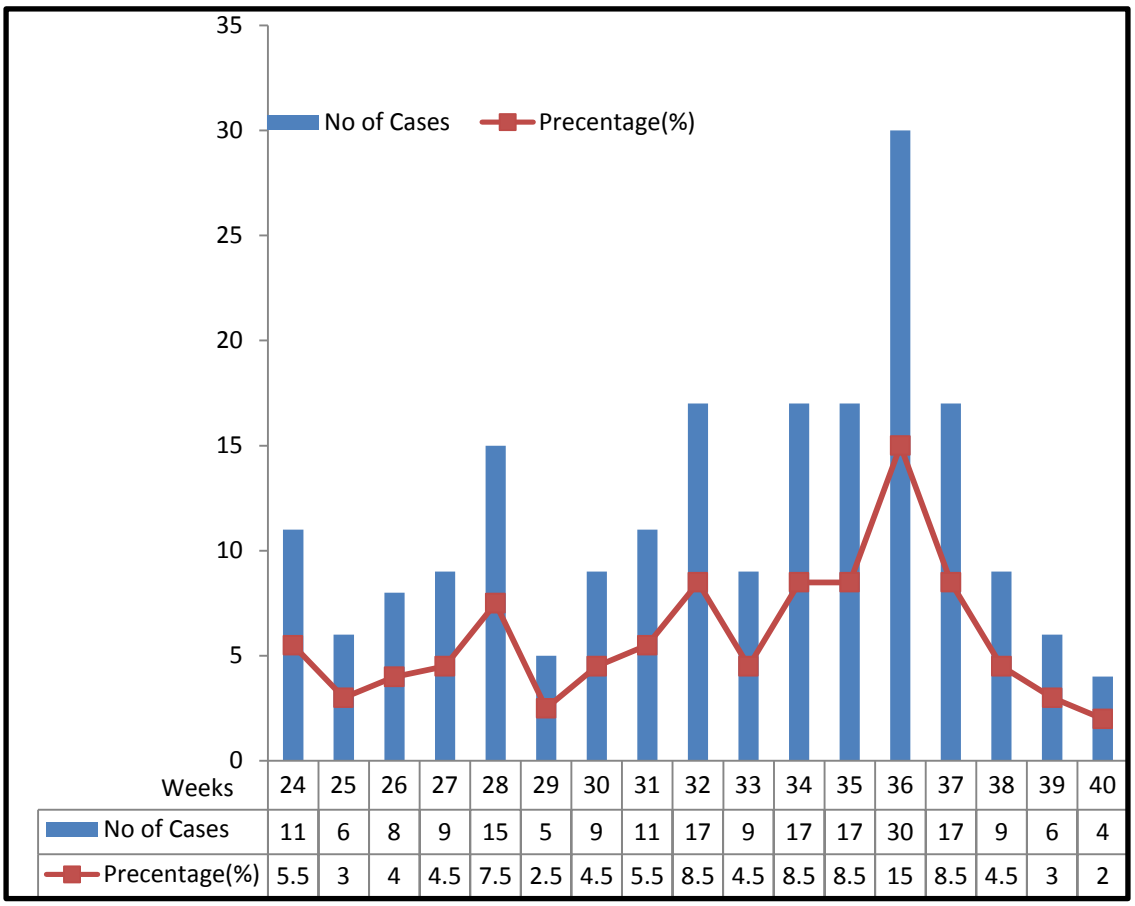
This table shows that:

- 15% of women belonged to 36 weeks of gestation.
- 4.5% of women belonged to 27 weeks, 33 weeks and 38 weeks of gestation.

The number of cases in each gestational age was selected randomly.

Diagram 4:

DISTRIBUTION OF CASES IN EACH GESTATIONAL AGE:



Weeks	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
No of Cases	11	6	8	9	15	5	9	11	17	9	17	17	30	17	9	6	4
Precentage(%)	5.5	3	4	4.5	7.5	2.5	4.5	5.5	8.5	4.5	8.5	8.5	15	8.5	4.5	3	2

TABLE 5 :

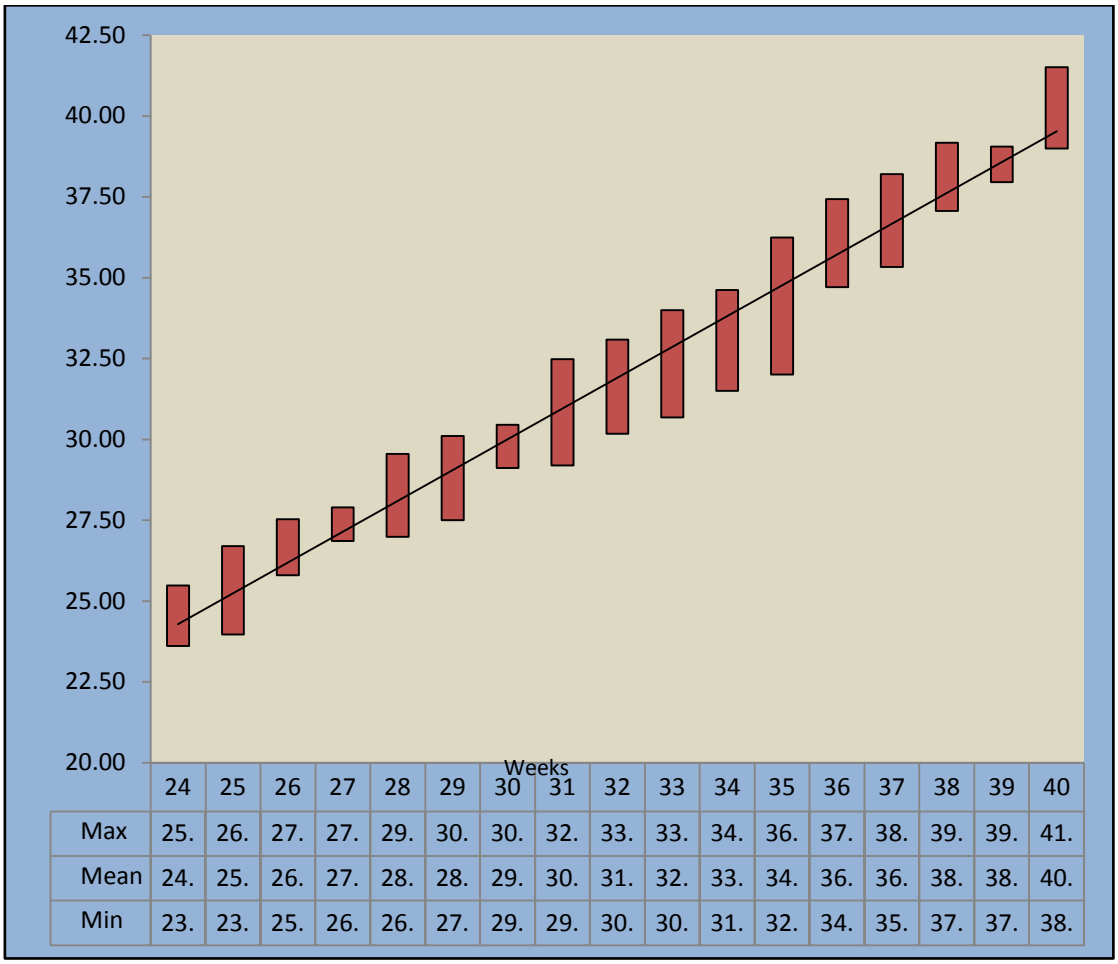
Mean foetal kidney length at various gestational ages:

Gestational age in weeks	Mean foetal kidney length	Standard deviation	Confidence interval
24	24.54	0.93	23.60 to 25.47
25	25.33	1.37	23.96 to 26.69
26	26.67	0.87	25.80 to 27.53
27	27.38	0.52	26.85 to 27.89
28	28.27	1.28	26.98 to 29.54
29	28.80	1.30	27.49 to 30.10
30	29.78	0.67	29.11 to 30.44
31	30.83	1.64	29.19 to 32.47
32	31.63	1.45	30.17 to 33.07
33	32.33	1.66	30.67 to 33.99
34	33.06	1.56	31.49 to 34.61
35	34.12	2.12	31.99 to 36.23
36	36.07	1.36	34.70 to 37.42
37	36.76	1.44	35.32 to 38.20
38	38.11	1.05	37.05 to 39.16
39	38.50	0.55	37.95 to 39.04
40	40.25	1.26	38.99 to 41.50

This table shows the mean fetal kidney length in mm for each gestational age. The mean fetal kidney length was the average of right and left kidney measurement. Mean fetal kidney length increased linearly with increase in gestational age.

Diagram 5:

MEAN FETAL KIDNEY LENGTH (FKL) AT VARIOUS GESTATIONAL AGE :



	24	25	26	27	28	29	30	31	32	33	34	35	36	37	38	39	40
Max	25.	26.	27.	27.	29.	30.	30.	32.	33.	33.	34.	36.	37.	38.	39.	39.	41.
Mean	24.	25.	26.	27.	28.	28.	29.	30.	31.	32.	33.	34.	36.	36.	38.	38.	40.
Min	23.	23.	25.	26.	26.	27.	29.	29.	30.	30.	31.	32.	34.	35.	37.	37.	38.

Table 6:

Mean and standard deviation of gestational age derived from various indices compared with clinical gestational age:

GA IN WEEKS	BPD		HC		AC		FL		KL	
	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD	MEAN	SD
24	23.18	1.57	23.00	1.41	23.61	1.14	21.36	1.2	24.55	0.934
25	24	2	24.33	1.75	23.92	2.31	23.17	2.22	25.17	1.32
26	24.78	1.64	25.33	1.41	26.23	2.63	25.22	2.16	26.56	0.88
27	25.5	1.41	26	0.75	26.64	1.06	24.88	0.64	27.25	0.46
28	27.13	1.72	27.53	0.99	28.23	0.82	27.27	2.08	28.27	1.28
29	27	1.58	27.2	1.3	28.62	0.48	26.6	0.89	28.8	1.3
30	28.56	1.74	28.56	1.81	29.52	1.13	28.89	0.92	29.78	0.66
31	30.08	2.06	30.17	2.03	30.49	1.25	28.67	0.49	30.83	1.64
32	31.25	1.8	31.12	1.74	30.98	0.95	29.56	0.81	31.62	1.45
33	31.56	1.33	31.56	1.33	33.09	0.67	32.44	0.52	32.33	1.65
34	32.18	1.51	32.29	1.57	33.9	0.56	32.35	0.99	33.06	1.56
35	33	1.58	33.18	1.74	33.8	0.86	33.65	0.78	34.12	2.11
36	34.57	1.3	35.1	1.88	34.13	6.05	35.37	2.05	36.03	1.35
37	36.53	1.87	37.24	2.33	36.51	0.72	36.29	2.14	36.71	1.4
38	37	1.87	37.22	2.16	37.16	1.25	36.89	2.14	37.89	0.78
39	35.83	0.75	36.5	1.22	38.07	0.8	38.33	1.36	38.83	0.75
40	38	1.41	37.5	1.91	39.48	0.09	39	0.81	40.25	1.25

- This table shows the mean and standard deviation of various fetal indices for each gestational age.
- In early weeks of gestation based on the mean and standard deviation, it can be inferred that all parameters are reliable for gestational age assessment.

Diagram 6:

ASSOCIATION BETWEEN GESTATIONAL AGE AND BPD, HC, AC, FL , FKL:

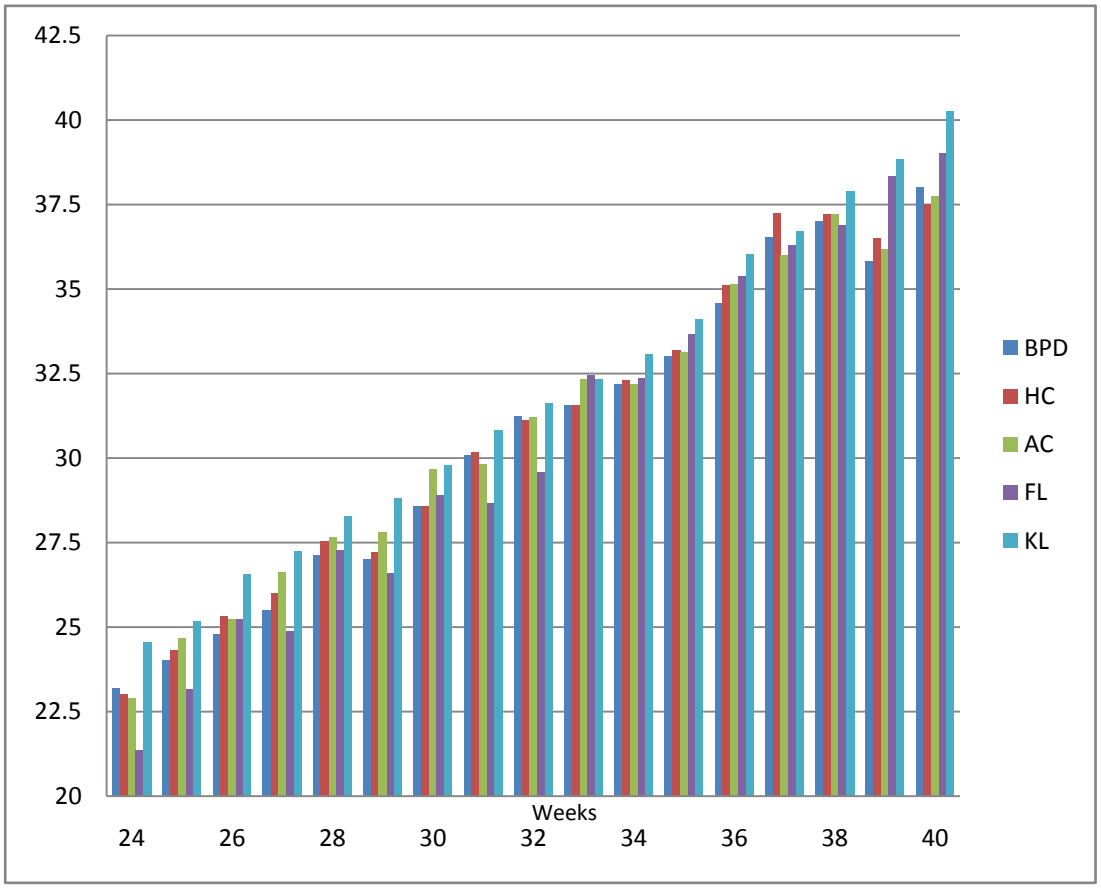


Table 7:

Correlation co-efficient of clinical gestational age with

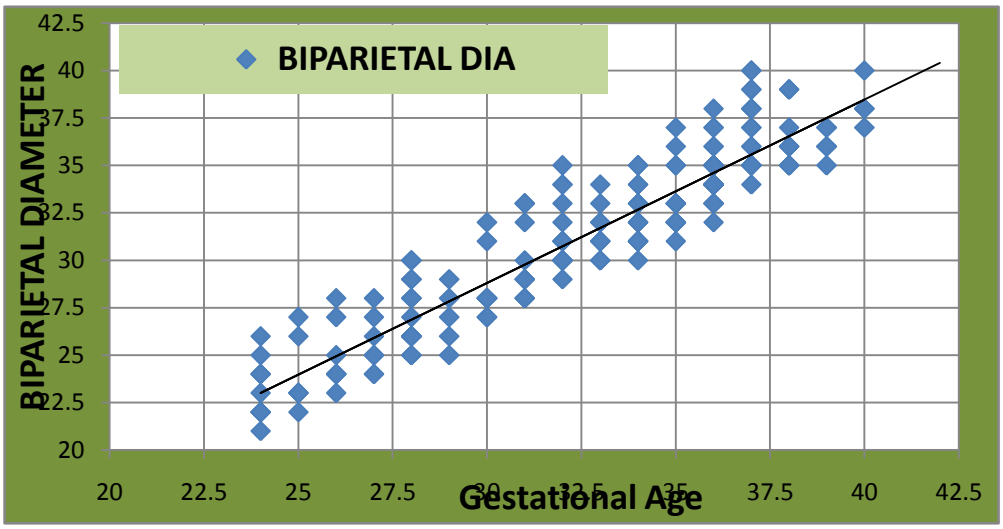
BPD,HC,AC,FL,FKL gestational age :

Pair	CGA Vs BPD GA	CGA Vs HC GA	CGA Vs AC GA	CGA Vs FL GA	CGA Vs FKL GA
Karl Pearson Correlation	0.931	0.924	0.917	0.947	0.949
P value	< .001	< .001	< .001	< .001	< .001

- This table shows the association between the foetal measurements and CGA.
- The correlation for CGA vs BPD, HC and FL was almost similar (r : 0.931, 0.924, 0.947 respectively).
- The correlation was best for CGA vs FKL(r: 0.949) and least for CGA vs AC (r : 0.917).
- All the correlations were statistically significant.

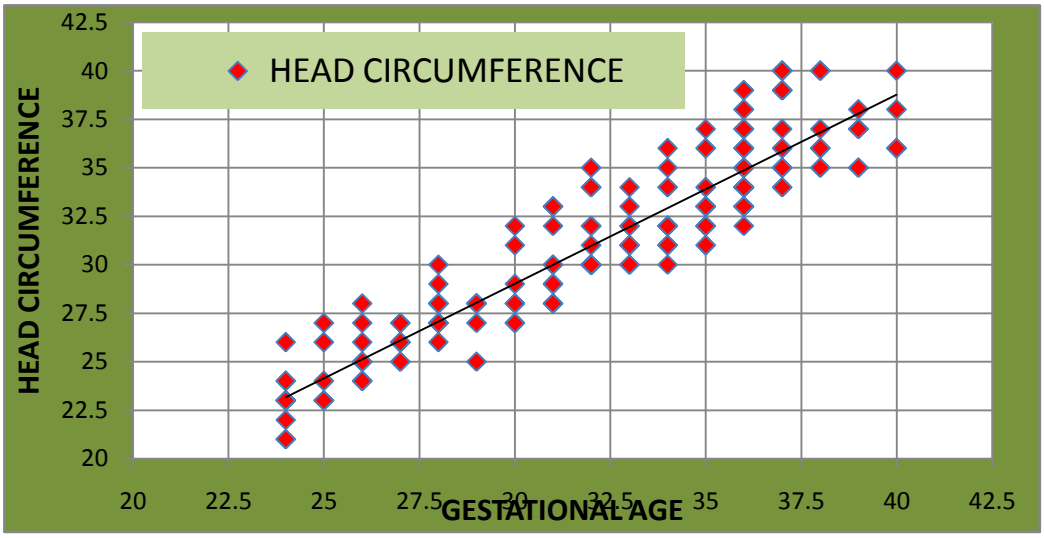
Diagram 7 :

Clinical Gestational Age Vs Biparieal diameter



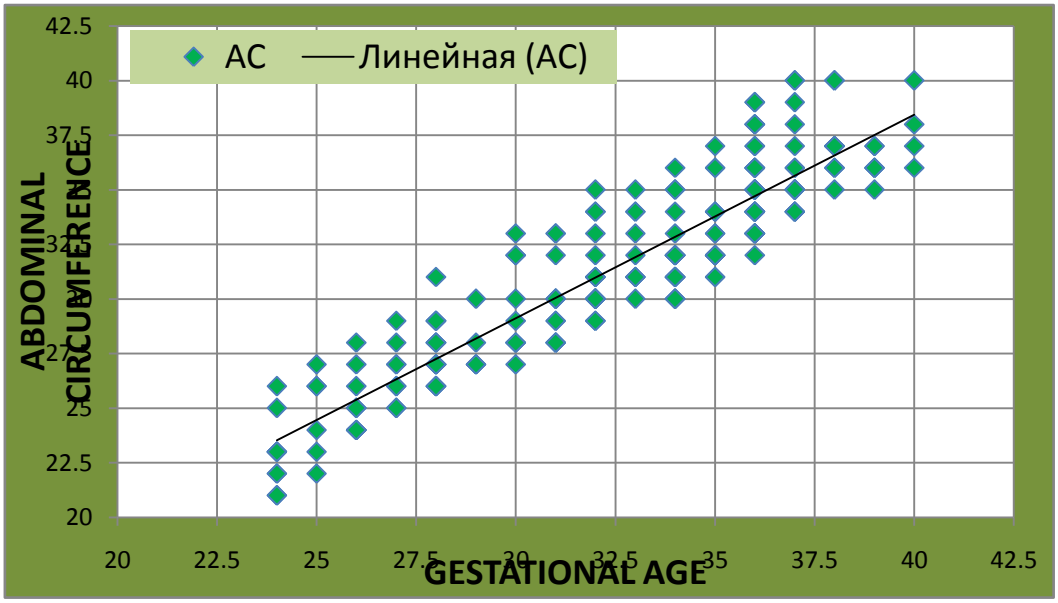
This scatter diagram shows the correlation of 93.1% between BPD GA and CGA in both trimesters.

Clinical Gestational Age Vs Head circumference



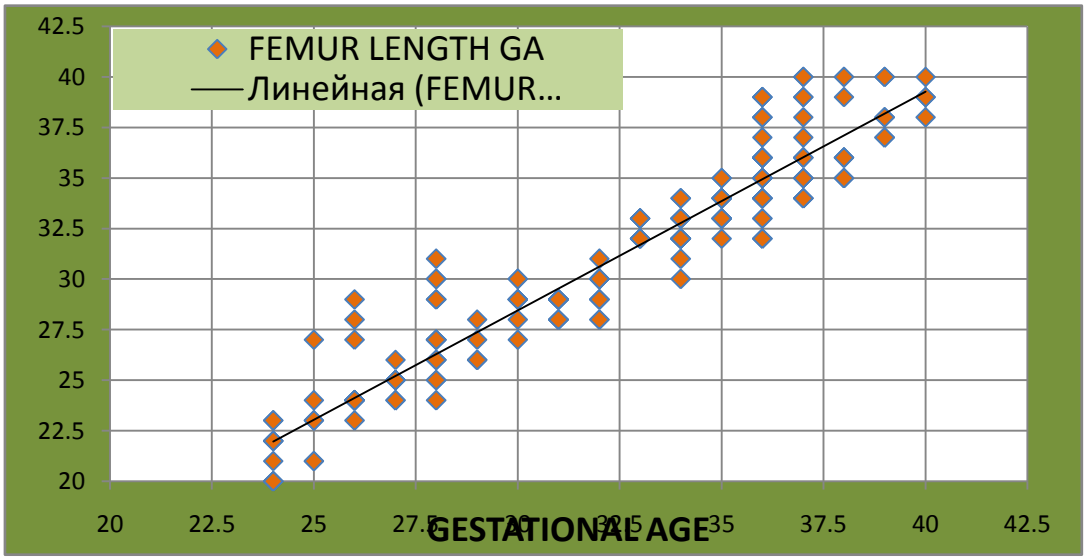
This scatter diagram shows the correlation HC GA with CGA. HC GA has correlated with CGA by 92.4%.

Clinical Gestational Age Vs Abdominal circumference



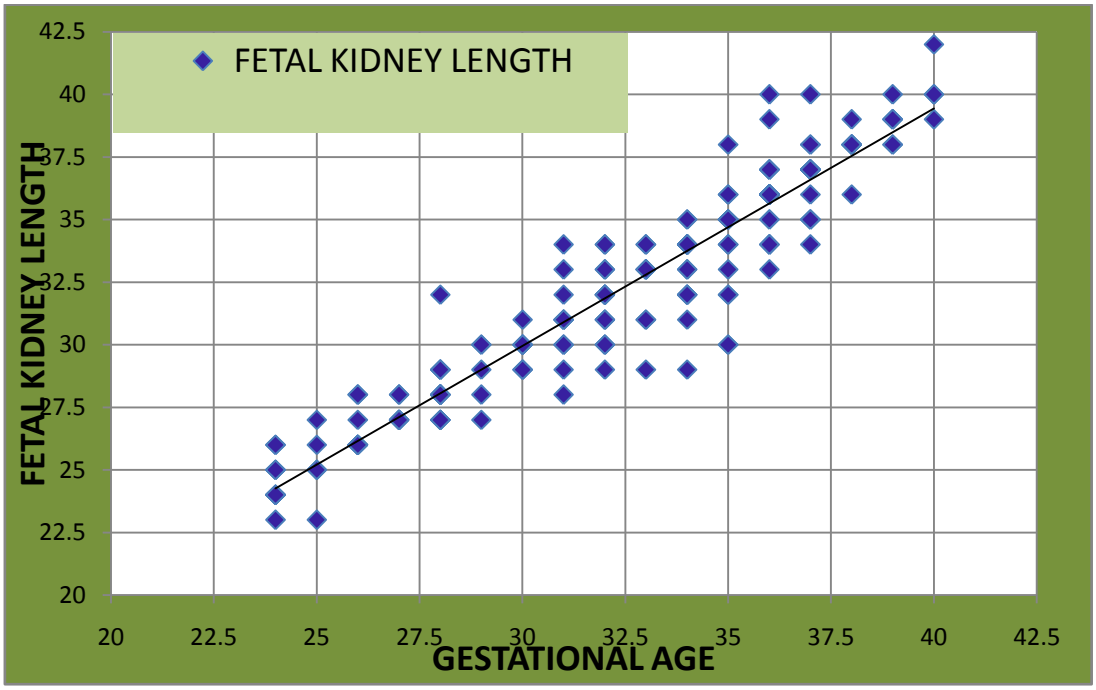
This scatter diagram shows the correlation of AC GA with CGA in both trimester. Here AC GA has correlated with CGA by 91.7%.

Clinical Gestational Age Vs Femur length



This scatter diagram is showing the correlation of FL GA with CGA in both trimester. Here FL GA has correlated with CGA by 94.7%.

Clinical Gestational Age Vs Fetal kidney length



- This scatter diagram is showing the correlation of FKL GA with CGA in both trimester. Here FKL GA has correlated with CGA by 94.9%.
- All the correlations were statistically significant.

Table : 8

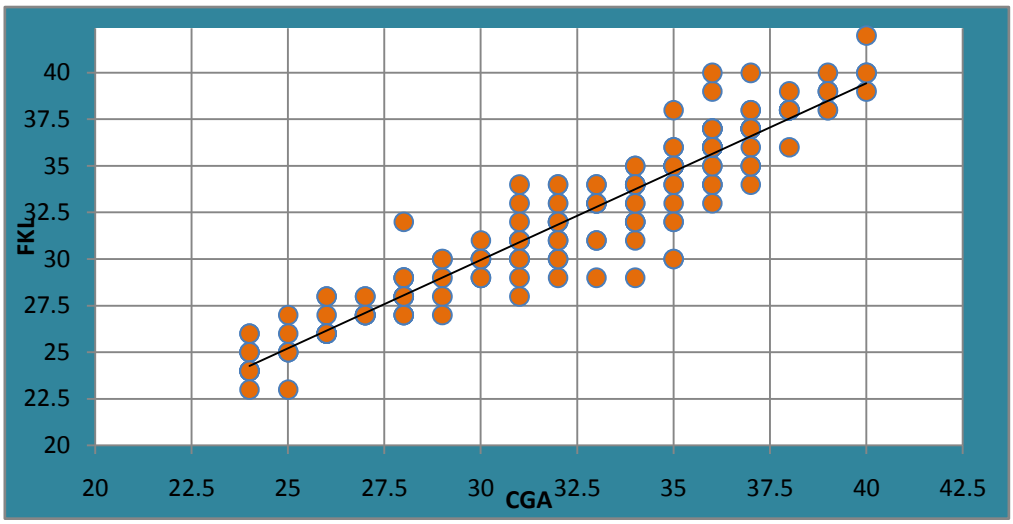
Correlation co-efficient of FKL GA with CGA, BPD, HC, AC, FL GA:

pair	FKL GA Vs CGA	FKL GA Vs BPD	FKL GA Vs HC GA	FKL GA VS AC GA	FKL GA Vs FL GA
Pearson correlation	0.949	0.877	0.873	0.858	0.908
P- value	<.001	< .001	< .001	.001	< .001

- The above shown table reveals the association between the foetal measurements and FK GA .
- The correlation was best for FK GA vs CGA, FL (r : 0.949 and0.908) and least for FK GA vs AC (r: 0.858).
- All the correlations were statistically significant.

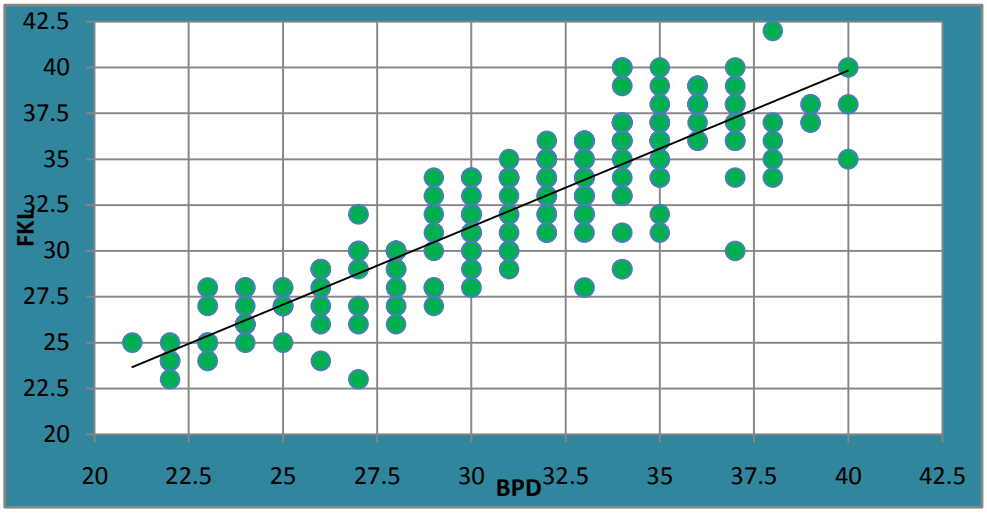
Diagram 8:

FKL Gestational Age Vs CGA



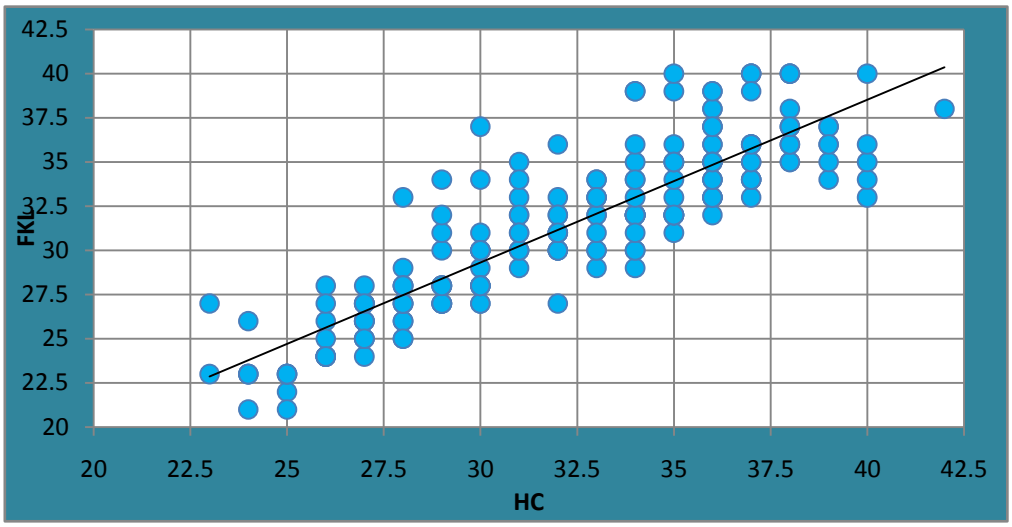
A scatter diagram showing the correlation and regression analysis of the FK GA with CGA in both trimester. Here FK GA has correlated with CGA by 94.9%.

FKL Gestational Age Vs Biparieal diameter



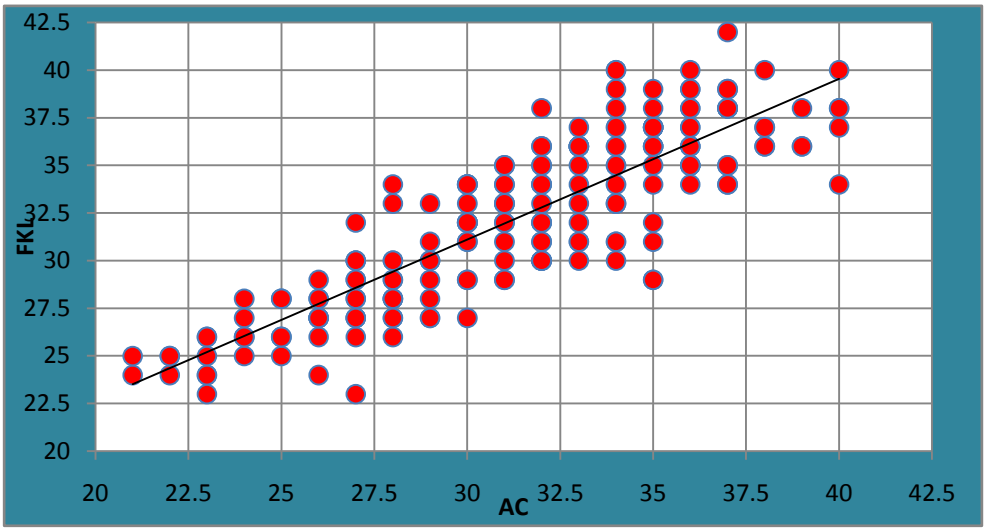
A scatter diagram showing the correlation and regression analysis of the FK GA with BPD in both trimester. Here FK GA has correlated with BPD by 87.7%.

FKL Gestational Age Vs HC GA



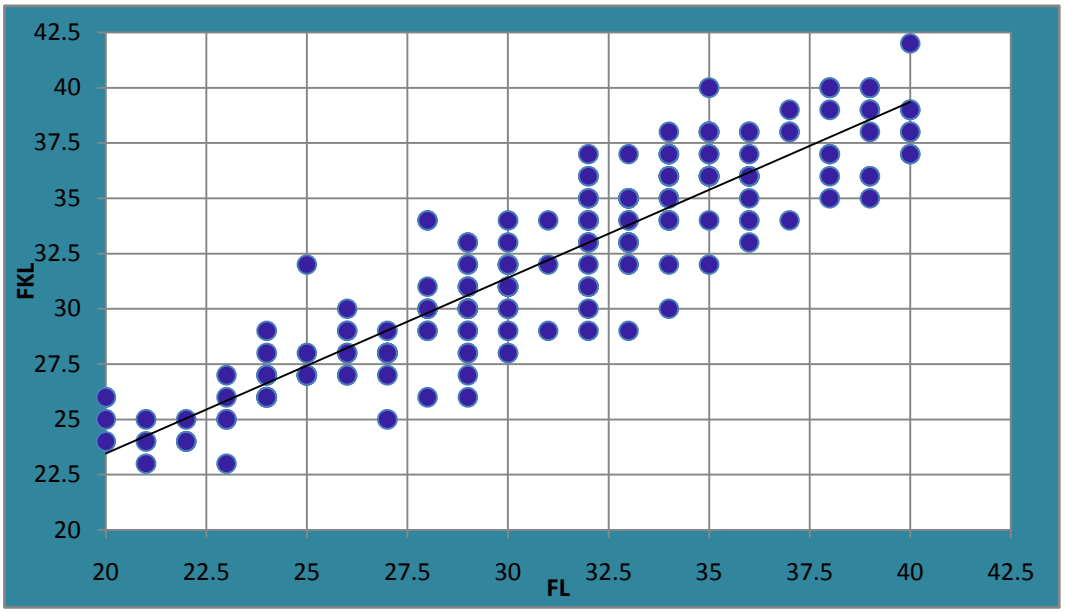
A scatter diagram showing the correlation and regression analysis of the FK GA with HC in both trimester. Here FK GA has correlated with HC by 87.3%.

FKL Gestational Age Vs AC GA



A scatter diagram showing the correlation and regression analysis of the FK GA with AC GA in both trimester. Here FK GA has correlated with AC by 85.8%.

FKL Gestational Age Vs FL GA



A scatter diagram showing the correlation and regression analysis of the FK GA with FL in both trimester. Here FK GA has correlated with FL by 90.8%.

Table 9:

Linear regression equation: comparison between the present study and the Study by konje et al 2002

	study	Intercept estimate	Intercept SE	Slope estimate	Slope SE	P -value	R^2	SEp (days)
BPD	present	3.516	0.88	0.96	0.027	<.05	87	11.5
	Konje et al	3.808	0.44	0.38	0.005	<0.005	88	11.6
HC	Present	3.632	0.94	0.97	0.029	<.05	85	12.4
	Konje et al	3.013	0.49	0.12	0.002	<0.005	89	11.2
AC	present	3.340	0.94	0.93	0.02	<0.05	84	12.6
	Konjeetal	5.493	0.45	0.97	0.002	<0.005	81	14.5
FL	present	4.460	0.85	1.08	0.026	<0.05	89	11.3
	Konje et al	5.00	0.34	0.449	0.005	<0.05	89	10.9
FKL	present	3.438	0.73	0.94	0.022	<0.05	90	9.8
	Konje et al	3.821	0.38	0.858	0.012	<0.05	90	10.2

This table shows the comparison of different biometric indices of the present study and study by konje et al.

- FKL in the present study dates pregnancy within $\pm$ 9.8 days.
- In konje et al study, FKL dates pregnancy with an accuracy of $\pm$ 10.2 days.
- AC is the worst predictor, FKL is the best predictor in comparison with other biometric indices for estimation of gestational age.

Diagram 9 :

MEAN FETAL KIDNEY LENGTH (FKL) AT VARIOUS GESTATIONAL AGE

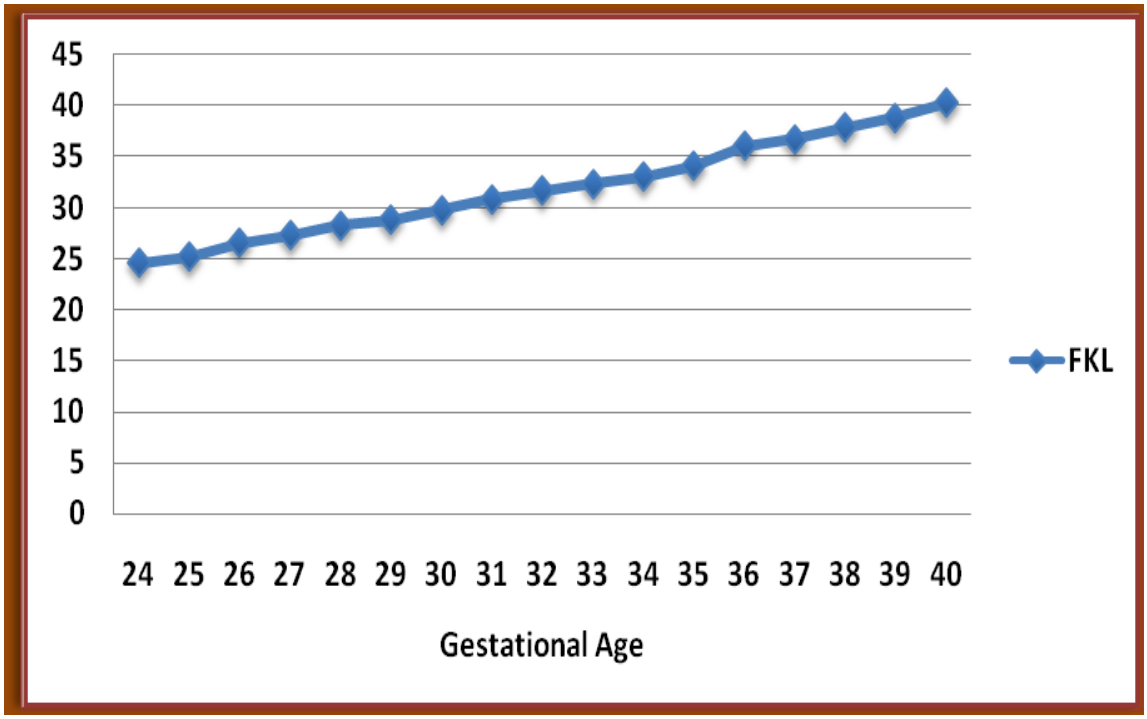


Table 10:

Comparison of findings in kidney length of foetus of the present study with other studies:

Gestational Age (weeks)	Kidney length(mm) (SD) S.Afroz et al 1996	Kidney length (mm) Ansari et al 1997	Kidney length (mm) Present study
31	30.00(1.51)	32.00 (0.50)	30.83 (1.64)
32	32.87(4.83)	32.00 (0.51)	31.62 (1.45)
33	32.80(1.26)	32.00 (0.70)	32.33 (1.65)
34	34.00(2.91)	33.00 (0.66)	33.06 (1.56)
35	35.00(2.22)	34.00 (0.62)	34.12 (2.11)
36	35.64(2.89)	35.00 (0.79)	36.03 (1.35)
37	37.00(3.53)	36.00 (0.79)	36.71 (1.40)
38	37.33(2.31)	37.00 (0.74)	37.89 (0.78)
39	38.67 (2.00)	38.00 (0.56)	38.83 (0.75)
40	40.20 (2.97)	39.50 (0.58)	40.25 (1.25)

The kidney length of the present study were compared with studies by Ansari et al and Afros et al and it showed a close correlation with these two studies.

Diagram 10:

Comparison of findings in kidney length of foetus of the present study with other studies :

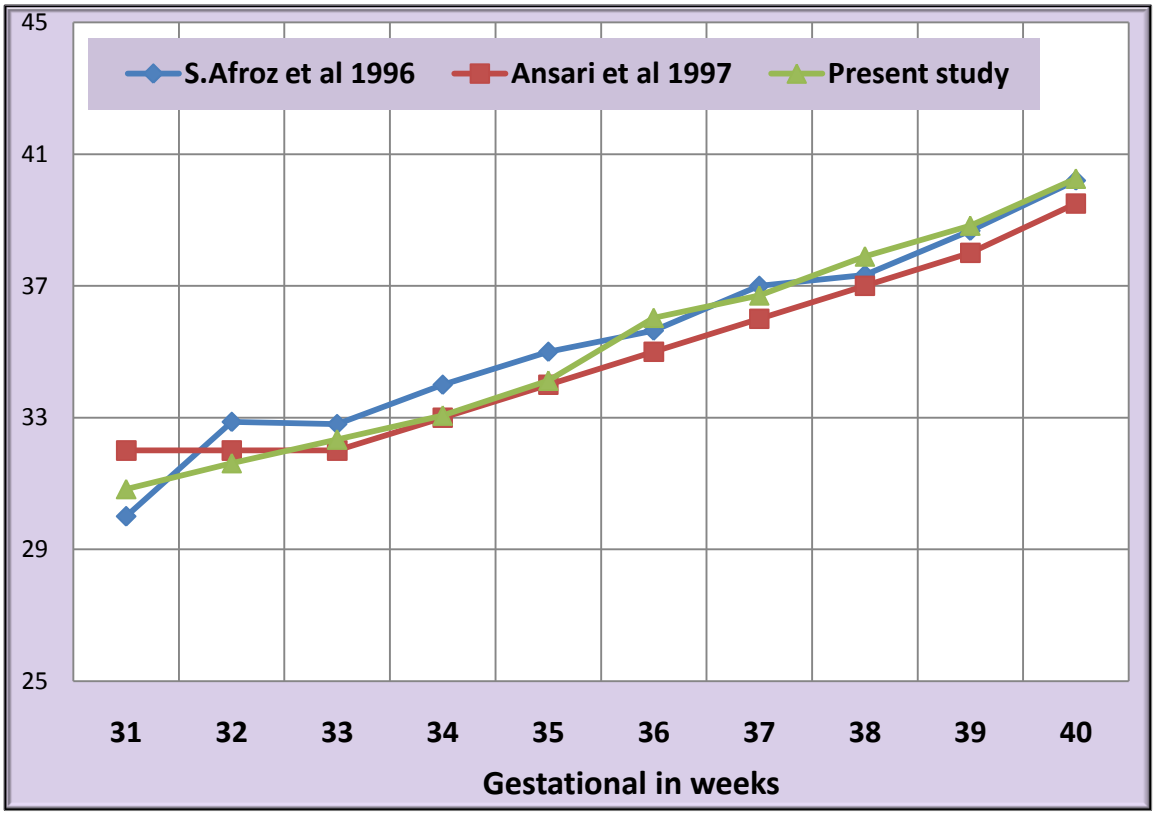


Table 11:

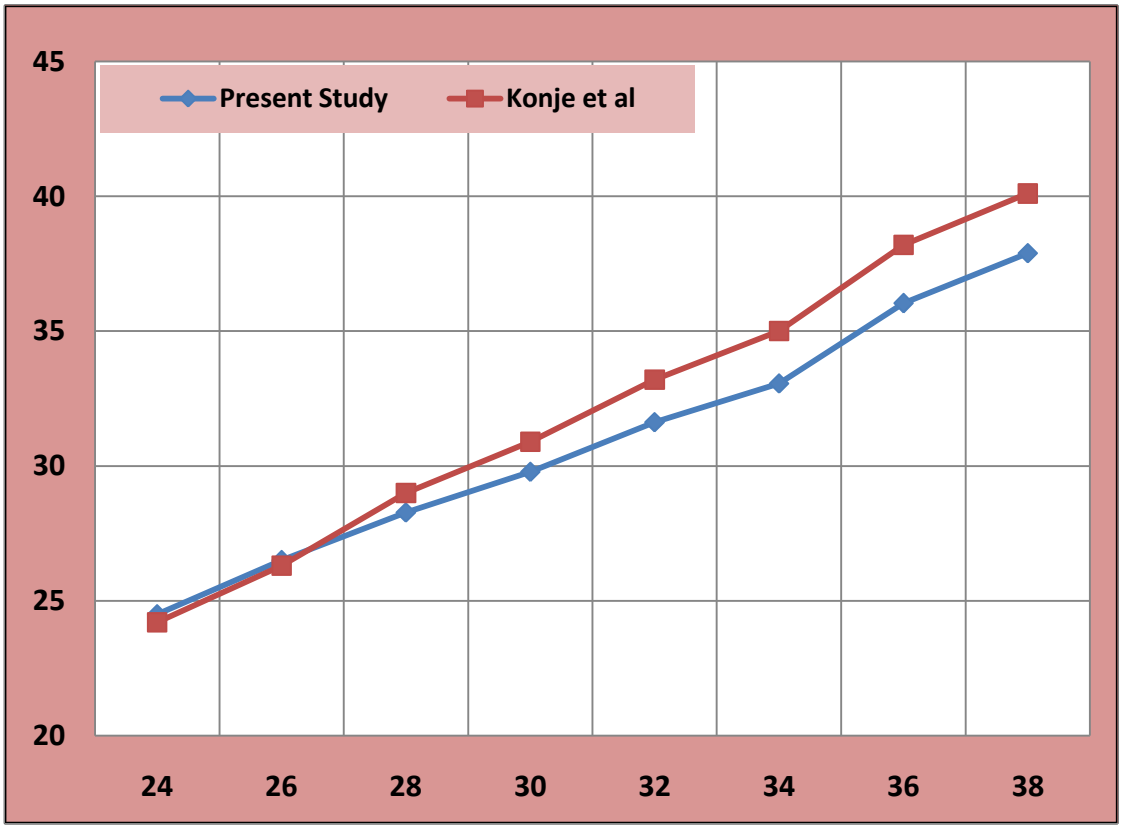
Comparison between the mean fetal kidney length of the study with that of the study done by konje et al 2002

Gestational (in weeks)	Mean fetal kidney length (SD) in the study(mm)	Mean foetal kidney length (SD) in the study by konje et al
24	24.50(.93)	24.2(1.2)
26	26.50(.88)	26.3(1.9)
28	28.27(1.2)	29.0(2.2)
30	29.78(0.66)	30.9(3.2)
32	31.62(1.4)	33.2(4.5)
34	33.06(1.5)	35(3.6)
36	36.03(1.3)	38.2(4.2)
38	37.89(0.78)	40.1(2.4)

- This table shows the comparison between the mean fetal kidney length of the present study with that of the study by konje et al 2002.
- The values for fetal kidney length at different gestational ages were same or lower than the study by konje et al.

Diagram 11:

Comparison between the mean fetal kidney length (mm) of the study with that of the study done by KONJE et al 2002



DISCUSSION

DISCUSSION

Diagnostic ultrasound is a non-invasive, safe and useful investigation in the antepartum surveillance of the fetus. It was only in the late 1950s that Ian Donald first introduced ultrasound into obstetrics. Stuart Campbell was the person who first used ultrasound to diagnose a congenital anomaly, anencephaly in 1960.

several studies have been done earlier to assess the variability in gestational age determination from FKL. They found that there is a linear relationship between the fetal kidney length in mm and the gestational age in weeks. our study was done to find out any difference in Indian population.

Our study shows that the age, parity, sides of kidney has no significant bearing in the measurement of kidney length, and in the estimation of gestational age.

Our study result shows that gestational age can be calculated from fetal kidney length with a difference of $\pm$ 9.8 days from late second trimester and third trimester. It will be useful in patients who forgot their date of LMP, and do not have dating scan done in first trimester and

coming for antenatal check-up late. It is correlated with the study by J J Kansaria et al 2009.

In our study, it has shown that BPD dates pregnancy with the accuracy of ± 11.5 days, HC by ± 12.4 days, FL by ± 11.3 days, AC by ± 12.6 days, suggesting that AC is the worst predictor .

The linear regression analysis was done comparing individual variable with clinical gestational age derived from LMP and dating scan as standard. This was compared with the study done by Konje et al 2002.

The fetal kidney length found to be the most accurate parameter for determination of gestational age with a standard error (SE) of 10.2 days in the study by Konjeet al and 9.8 days by this study. The abdominal circumference was the most inaccurate parameter with a standard error of 14.5 days in the study by Konje et al and 12.6 days in this study.

As like other organs fetal kidney size also affected by growth variations. But these will affect only the antero posterior and transverse diameter of the kidney. The length of the fetal kidney is not affected by growth variations.

Rule of thumb is that

“renal length in mm approximates Gestational Age in weeks”.

In our study we found that the mean fetal kidney length increased linearly as the gestational age increases. Gestational age determined by fetal kidney length correlated better with gestational age derived from other biometric indices like BPD,FL,HC,AC. This result is found to be similar with the study by konje et al 2002.

The present study hence validates the recommendation that fetal kidney length can be used as an important sonographic parameter for accurate prediction of fetal Gestation age .The results of present study and previously published studies on FKL shows that additional small improvements in accurate estimation of gestational age can be achieved by incorporating the results of FKL with some combination of other fetal biometric parameters, including biparietal diameter head circumference, abdominal circumference, and femur length. Nevertheless, the best combination of biometric measurements remains to be determined.

However it should always be remembered that a single USG Examination for determining gestational age is unreliable after 30 weeks. So fetal kidney length measurement can be taken as an additional parameter for accurate estimation of gestational age in late trimester in combination with BPD, FL, AC.

SUMMARY & CONCLUSION

SUMMARY

Well dated 200 antenatal women from 24 to 40 weeks of gestation with no obstetric or medical risk factors were recruited for this study. The study group was selected randomly and distributed according to age ,parity and trimester.

The gestational age was assessed using fetal kidney length and other routinely used parameters (BPD, FL, AC, HC) and the results were compared. .

Both kidneys right and left were measured . It showed that the right and left kidney length were almost the same for the same gestational age. Our study shows that the age, parity, sides of kidney show no significant bearing in the assessment of renal length and its correlation to gestational age.

The length of the kidney showed linear correlation with increasing gestational age. This study has dated pregnancy within $\pm$ 9.8 days by measuring kidney length.

CONCLUSION

In our study, patients with known dates of LMP were taken and their fetal kidney measurements were recorded and gestational age assessed prenatally. Our study shows that the age, parity, sides of the kidney shows no significant bearing in the assessment of renal length and its correlation to gestational age.

In our study, it has shown that fetal kidney length dates pregnancy within ± 9.8days. BPD dates pregnancy with the accuracy of ± 11.5 days, HC by ± 12.4 days, FL by ± 11.3 days, AC by ± 12.6 days, suggesting that AC is the worst predictor .

So from this study we concluded that ,

1. Fetal kidney length measurement correlated well with other routinely used parameters for the estimation of gestational age.
2. Fetal kidney length measurement is the accurate parameter to date pregnancy.
3. It can be combined with other routinely used parameters (BPD, FL, AC) to date pregnancy more accurately.

PROFORMA

PROFORMA

Name:

Age: O.P.NO:

Sex: Occupation:

Address: Socioeconomic status

Booked case:

Last menstrual period:

Expected date of delivery:

Period of gestation:

Present History:

Time of onset of prenatal care :

Pregnancy confirmation method :

Dating scan:

Obstetric History:

- Gravida:
- Para:
- Living:
- Abortion**:**

Menstrual history:

Regularity:

Flow:

Past medical history:

Personal history:

Family history:

General physical examination:

Height	Weight	BMI:
Pallor	Edema	Pulse
B. P	Respiratory rate	Temperature:
Thyroid	Breast	Spine:

Cardiovascular system :

Respiratory system :

Abdominal examination :

- Uterine size:
- Uterine activity:
- Lie:
- Presentation:
- Position :
- Symphysio fundal height:
- Abdominal girth:
- Fetal heart rate:

Investigations :

Hemoglobin:

Blood group:

G.C.T.

H.I.V

HBsAg :

V.D.R.L:

Urine microscopy:

Ultrasound :

Fetal number:

Presentation:

Amniotic fluid index:

Anomalies:

Placentation:

Biometry:

Biometry	meanFKL	BPD	HC	FL	AC
Gestational age (weeks)					

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ABBREVIATION

GA	-	Gestational age
HC	-	Head circumference
FL	-	Femur length
AC	-	Abdominal circumference
BPD	-	Biparietal diameter
FKL	-	Foetal Kidney length
USG	-	Ultrasonography
IUGR	-	Intrauterine growth retardation
LMP	-	Last Menstrual Period
EDD	-	Expected Date of Delivery
CGA	-	Clinical gestational age

MASTER CHART

MASTER CHART

S.NO	OP NO	AGE	PARITY	CGA (WEEKS)	BPD GA (WEEKS)	HC GA (WEEKS)	AC GA (WEEKS)	FL GA (WEEKS)	FKL GA (WEEKS)
1	8532	22	P	24	24	24	23	20	26
2	2463	26	M	24	22	23	21	22	24
3	1425	23	M	24	24	22	25	22	25
4	6274	22	P	24	22	23	23	20	24
5	2954	24	M	24	21	21	22	23	25
6	2784	18	P	24	26	26	26	21	24
7	4219	27	M	24	25	23	21	20	25
8	3956	25	M	24	22	23	23	22	24
9	590	19	P	24	23	21	22	22	24
10	4258	22	P	24	24	24	23	20	26
11	6319	26	M	24	22	23	23	23	23
12	2794	24	P	25	23	24	26	23	27
13	2916	26	M	25	27	27	27	21	23
14	4820	18	P	25	26	26	26	24	26
15	3163	26	M	25	22	23	23	23	25
16	2736	23	M	25	23	23	22	27	25
17	7316	19	P	25	23	23	24	21	25
18	4963	23	P	26	24	24	24	24	26
19	6295	19	P	26	28	28	28	29	26
20	3941	25	M	26	27	27	27	23	26
21	2931	18	P	26	25	25	24	24	27
22	2931	24	P	26	24	24	24	28	26
23	2941	26	M	26	24	25	25	24	26
24	3193	24	M	26	23	26	26	24	28
25	2736	22	M	26	24	24	25	24	26
26	8211	25	M	26	24	25	24	27	28
27	3954	27	M	27	25	27	26	24	27
28	3421	19	P	27	25	26	26	24	27
29	2323	23	P	27	24	26	25	25	28
30	4237	27	M	27	27	25	27	25	27
31	2957	22	P	27	24	27	28	25	27
32	5173	25	M	27	28	26	29	25	27
33	2854	19	P	27	25	25	25	26	28
34	3074	30	P	27	26	26	27	25	27
35	4087	24	M	28	30	30	31	24	29
36	5046	26	P	28	29	29	29	27	28
37	7351	26	M	28	26	28	28	27	28
38	9416	23	P	28	26	28	27	26	29
39	2804	25	M	28	26	27	27	29	28
40	549	24	M	28	25	27	27	25	27
41	4905	25	M	28	26	27	29	30	29
42	4062	24	P	28	28	28	28	29	27
43	5835	25	M	28	25	27	27	26	28

S.NO	OP NO	AGE	PARITY	CGA (WEEKS)	BPD GA (WEEKS)	HC GA (WEEKS)	AC GA (WEEKS)	FL GA (WEEKS)	FKL GA (WEEKS)
44	3640	22	P	28	26	27	26	31	29
45	7390	31	P	28	26	26	26	27	27
46	3946	25	P	28	28	28	28	30	28
47	5629	22	P	28	27	27	27	25	32
48	5036	29	M	28	29	27	29	26	27
49	4437	28	M	28	30	27	26	27	28
50	1392	27	M	29	26	28	27	26	29
51	907	23	P	29	29	28	28	27	28
52	1935	22	P	29	25	25	30	26	27
53	2195	26	M	29	28	28	27	26	30
54	3021	22	P	29	27	27	27	28	30
55	2041	26	M	30	28	27	28	27	29
56	1730	21	P	30	27	29	29	29	30
57	3810	25	M	30	28	27	28	29	30
58	4284	21	P	30	28	28	32	29	30
59	3629	24	M	30	32	32	33	30	31
60	3910	21	P	30	28	28	30	29	29
61	4017	26	M	30	31	31	32	28	30
62	3901	22	P	30	27	27	28	29	29
63	6150	24	M	30	28	28	27	30	30
64	9271	22	P	31	28	28	29	29	30
65	3017	33	M	31	29	29	28	29	33
66	3012	25	P	31	33	33	29	29	31
67	7201	24	P	31	28	28	33	28	30
68	8402	22	P	31	29	29	28	28	34
69	2618	27	M	31	32	32	30	29	31
70	1037	26	M	31	30	30	32	28	31
71	9274	22	P	31	29	29	33	29	31
72	2014	28	M	31	33	33	28	29	28
73	6392	26	P	31	28	28	30	28	29
74	1846	26	M	31	29	30	28	29	30
75	4103	28	P	31	33	33	30	29	32
76	8320	23	M	32	30	30	33	29	32
77	3701	25	M	32	34	34	35	28	29
78	3750	25	M	32	35	35	34	30	31
79	6183	24	P	32	30	30	32	29	30
80	4038	22	P	32	30	30	30	30	32
81	5820	27	M	32	29	30	30	30	32
82	1630	19	P	32	30	30	31	29	30
83	9362	25	M	32	32	32	29	29	33
84	4926	22	P	32	30	30	30	28	34
85	6103	21	P	32	31	30	29	30	30
86	4820	27	M	32	31	30	30	30	33
87	5810	22	P	32	33	31	31	30	32
88	4820	27	M	32	34	30	34	30	31

S.NO	OP NO	AGE	PARITY	CGA (WEEKS)	BPD GA (WEEKS)	HC GA (WEEKS)	AC GA (WEEKS)	FL GA (WEEKS)	FKL GA (WEEKS)
89	4725	25	M	32	30	34	31	30	31
90	4281	25	P	32	30	30	30	30	32
91	1052	19	P	32	31	32	30	31	34
92	592	29	M	33	30	30	35	32	31
93	8310	21	P	33	30	30	34	33	33
94	4281	23	P	33	31	31	31	33	29
95	6204	26	M	33	31	31	30	32	31
96	7194	32	M	33	33	33	31	32	33
97	4930	22	P	33	31	32	33	32	34
98	4196	25	M	33	32	32	34	33	33
99	308	22	P	33	34	34	32	33	34
100	1963	27	M	33	32	31	31	32	33
101	4239	18	P	34	31	31	31	32	32
102	2091	26	M	34	34	32	35	32	29
103	1842	28	M	34	33	34	32	33	33
104	2151	21	P	34	35	35	34	32	34
105	6203	22	P	34	32	32	31	34	34
106	3081	29	M	34	32	32	32	33	34
107	921	18	P	34	31	31	32	32	31
108	2870	26	M	34	32	32	30	33	32
109	4238	24	P	34	31	30	36	30	34
110	39087	27	M	34	31	31	35	33	32
111	4184	23	P	34	32	32	30	34	34
112	920	24	P	34	35	36	32	31	32
113	7209	28	M	34	31	32	31	32	34
114	3719	21	P	34	31	32	31	32	35
115	4072	26	M	34	32	31	32	32	35
116	4982	25	P	34	30	32	30	32	34
117	5184	29	M	34	34	34	33	33	33
118	4289	19	P	35	33	33	34	34	34
119	849	32	M	35	33	33	33	34	36
120	5210	25	P	35	32	32	32	33	35
121	5973	21	P	35	35	36	37	34	35
122	8320	24	M	35	37	37	32	34	30
123	5321	24	M	35	36	36	32	34	38
124	329	23	P	35	32	32	36	33	35
125	6390	19	P	35	32	32	36	34	35
126	8520	28	M	35	33	33	34	33	35
127	2457	24	M	35	33	33	31	33	33
128	3407	23	P	35	32	32	32	35	32
129	6774	22	P	35	32	32	31	33	35
130	549	25	M	35	33	33	32	35	36
131	7092	23	M	35	33	34	33	33	35
132	5609	22	P	35	32	31	32	34	34
133	6562	19	P	35	32	31	32	34	32

S.NO	OP NO	AGE	PARITY	CGA (WEEKS)	BPD GA (WEEKS)	HC GA (WEEKS)	AC GA (WEEKS)	FL GA (WEEKS)	FKL GA (WEEKS)
134	6981	29	M	35	31	34	34	32	30
135	7809	33	M	36	35	36	33	36	36
136	9890	28	M	36	32	32	35	36	36
137	9087	21	P	36	34	33	32	34	36
138	1209	22	P	36	34	34	38	32	37
139	4344	27	M	36	38	39	36	35	36
140	5599	28	M	36	34	35	34	38	35
141	4345	21	P	36	37	39	35	35	34
142	703	23	P	36	35	36	37	37	34
143	5409	35	M	36	37	38	35	38	36
144	2954	27	M	36	34	34	33	34	36
145	3517	23	P	36	35	36	34	32	36
146	704	21	P	36	36	37	38	35	36
147	7589	24	M	36	35	37	36	36	36
148	7869	24	M	36	34	34	34	39	39
149	9080	24	P	36	34	33	33	34	37
150	4565	25	M	36	34	34	36	38	37
151	3896	28	M	36	33	33	35	36	36
152	705	22	P	36	33	34	33	39	36
153	2959	34	M	36	33	34	37	36	34
154	8604	27	M	36	36	38	39	34	36
155	6300	23	P	36	35	35	33	35	36
156	9766	25	P	36	34	33	34	39	40
157	9072	28	M	36	34	34	35	34	37
158	6031	24	M	36	35	35	39	36	36
159	5670	21	P	36	35	36	35	33	37
160	4087	35	M	36	35	35	36	33	35
161	7209	23	P	36	35	37	34	34	36
162	3027	31	M	36	33	34	38	32	36
163	5180	29	M	36	34	35	33	35	36
164	287	26	M	36	34	33	34	36	33
165	3905	23	P	37	34	34	34	35	37
166	4349	25	P	37	35	35	36	34	37
167	6082	25	M	37	38	39	40	36	34
168	4761	26	P	37	35	36	35	35	37
169	4268	27	M	37	35	35	35	40	37
170	7441	23	P	37	34	34	34	35	40
171	6310	26	M	37	39	40	35	36	37
172	9072	22	P	37	35	35	34	37	38
173	9507	28	M	37	38	40	38	40	37
174	5090	21	P	37	37	39	35	39	36
175	6809	27	M	37	36	37	39	35	38
176	2083	21	P	37	39	40	40	34	37
177	6401	23	P	37	35	35	35	36	35
178	4891	23	M	37	37	39	34	34	37

S.NO	OP NO	AGE	PARITY	CGA (WEEKS)	BPD GA (WEEKS)	HC GA (WEEKS)	AC GA (WEEKS)	FL GA (WEEKS)	FKL GA (WEEKS)
179	3968	24	M	37	38	39	36	34	35
180	2756	21	P	37	40	40	37	39	35
181	2126	26	M	37	36	36	35	38	37
182	3546	21	P	38	40	40	37	36	38
183	4355	30	M	38	35	35	36	36	36
184	2875	21	P	38	39	40	40	39	38
185	3443	24	M	38	36	36	35	40	39
186	5432	25	P	38	35	35	37	36	38
187	3850	26	M	38	36	36	36	35	38
188	6565	30	P	38	36	36	37	35	38
189	3098	26	M	38	37	37	40	35	38
190	1587	25	P	38	39	40	37	40	38
191	6723	27	M	39	35	35	36	38	40
192	3809	26	M	39	36	37	37	40	39
193	179	28	M	39	36	37	36	37	39
194	3655	23	M	39	36	38	36	37	38
195	3470	25	M	39	37	37	35	40	38
196	674	26	M	39	35	35	37	38	39
197	4275	31	M	40	37	36	36	39	39
198	5988	27	M	40	37	36	40	39	40
199	2877	26	M	40	40	40	38	38	40
200	5633	28	M	40	38	38	37	40	42